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C155-1352
T99062-05

27 April 2005

Ms. Kathleen Gerber
Department of the Air Force
AFCEE/ICS
806 13th Street, Suite 116
Vandenberg AFB, CA 93437

Subject: Final Site 32 Cluster Removal Action Work Plan (RAW), Installation Restoration Program Site 32 Cluster (32C), Vandenberg Air Force Base (AFB), CA

Reference: Contract No. F41624-03-D-8617, Task Order: 0062

Dear Ms. Gerber:

On behalf of the Air Force, with this letter, Tetra Tech, Inc. is submitting the replacement cover and spine for the Final Site 32C RAW. Copies are also being provided to the Department of Toxic Substances Control (DTSC) and the Regional Water Quality Control Board (RWQCB). Please replace the existing Draft Final 32C RAW cover and spine with the replacement cover and spine enclosed within.

If you have any questions regarding this matter, please feel free to contact David Springer by phone at (805) 681–3100, extension 113, by Fax at (805) 681-3108, or by email at david.springer@tetratech.com.

Sincerely,

TETRA TECH, INC.

David Springer

David Springer, P.G. No. 6962
Principal Hydrogeologist

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EXECUTIVE SUMMARY

Environmental investigations conducted at Installation Restoration Program (IRP) Sites 32 (Missile Silo 576-D) and 35 (Missile Silo 576-G), Vandenberg Air Force Base (AFB), indicate that previous missile launch activities have impacted groundwater quality forming discrete groundwater plumes downgradient of the missile silos Groundwater modeling indicates that natural attenuation processes alone are not sufficient to reduce the existing concentrations of trichloroethene (TCE), *cis*-1,2-dichloroethene (*cis*-1,2-DCE), and vinyl chloride concentrations below their respective remediation goals within a reasonable timeframe. At Site 32, the volatile organic compound (VOC) contaminated groundwater is flowing towards a perennial spring where the potential exists for exposure of TCE above the California Maximum Contaminant Level (MCL), once the plume reaches the spring. Results of the streamlined human health risk assessment suggest that concentrations of TCE pose non-negligible risks to receptors assumed to use groundwater as a potable resource (although there are no current plans to use groundwater as potable water at this site) This removal action work plan (RAW) addresses active remediation of trichloroethene (TCE) detected in groundwater downgradient of the Missile Silo 576-D at Site 32.

This RAW evaluates remedial alternatives, and screens and selects the most effective, implementable, and cost-effective interim removal action (IRA) approach suitable to address cleanup of TCE contamination in groundwater. The proposed IRA is compatible with the final remedy for Site 32, as will be presented in the Feasibility Study/Remedial Action Plan. Institutional controls (ICs) are considered a component of the remedies evaluated in accordance with California Health and Safety Code Sections 25316 and 25260 ICs will be included in the Feasibility Study/Remedial Action Plan, as a remedy component considered for the site. The comparative analysis of remedial alternatives presented in this RAW to address the chlorinated solvents at Site 32 is based on the nine National Contingency Plan (NCP) comparative criteria. The RAW also follows DTSC remedy selection process for hazardous substances release sites, pursuant to California Health and Safety Code Section 25356.1. Following the remedy selection, the RAW describes the basis, scope, and methodology for installation of the selected removal alternative. Based on these analyses, the Air Force recommends installation of a phytoremediation barrier oriented perpendicular to the groundwater plume east of El Rancho Oeste Road, to interdict the shallow groundwater plume migrating towards the spring at Site 32 The phytoremediation barrier alternative provides the lowest present-value cost of the active alternatives and best meets the removal action objectives and the NCP evaluation criteria Up to 360 arroyo willow trees will be planted in up to three rows, spaced 15 feet apart. The precise location of the barrier will be finalized following completion of a supplemental groundwater investigation, in which groundwater Hydropunch samples will be collected from Site 32 for purposes of better delineating the groundwater contamination plume. As the groundwater passes through the root system of the installed phytoremediation barrier, it will be absorbed into the willow tree root system whereby VOCs are anticipated to be metabolized via evapotranspiration. The focus of the IRA is for interim remediation of groundwater only. The Draft Final Remedial Investigation dated June 2004 concludes that the results of the human health risk assessment indicate acceptable risks for industrial workers, construction workers, and visitors exposed to contaminants of potential concern (COPCs) in soils. Similarly, ecological risks stem from hypothetical exposures to groundwater only Therefore, the interim response action is for groundwater only because soil does not pose a significant human health or ecological risk at the site. Future residents were not evaluated for exposures to COPCs in soil at this site. Sites 32 and 35 are currently, and will continue to be, designated for use as space launch complexes (Vandenberg AFB 2000), making future residential use of Sites 32 and 35 unlikely. As indicated in the MOA among Vandenberg AFB, DTSC, and the RWQCB (U.S. Air Force 1995), if future land use changes, the appropriate risk evaluation will be conducted.

Up to ten monitoring wells will be constructed upgradient, within, and downgradient of the barrier to assess its effectiveness at removing TCE and potential degradation daughter products from groundwater. Quarterly monitoring will be conducted for one year with analysis of VOCs and general mineral parameters. Water level data logging would be conducted for a six-month period during the growing season to document fluctuations in wells constructed within the planted area. Using this alternative, TCE concentrations at the spring are anticipated to fall below MCLs, thus mitigating the potential for adverse exposure of TCE to human and ecological receptors.

At Site 35, the chlorinated solvents TCE, *cis*-1,2-DCE, and vinyl chloride are present in groundwater at concentrations in excess of MCLs forming an ellipsoidal plume approximately 1,100 feet in length. The groundwater plume flows southwesterly and daylights at an intermittent groundwater seep. Along with the IRA to be implemented at Site 32, a Treatability Study at Site 35 will be implemented to evaluate the effectiveness of an in-situ reactive zone technology using emulsified soybean oil (electron donor technology) to promote reductive dechlorination of chlorinated solvents in groundwater upgradient of existing well 35-MW-8. The emulsified soybean oil, once injected into groundwater, is designed to slowly release hydrogen atoms over a period of many months to several years. The soybean oil degrades to fatty acids and glycerol, releasing hydrogen atoms at each step. Naturally occurring microorganisms capable of reductive dechlorination then use the hydrogen to progressively remove chlorine atoms from chlorinated hydrocarbons (i.e., convert TCE to DCE to vinyl chloride to ethene).

The installation of up to twenty new injection wells and ten new monitoring wells is proposed for this Treatability Study. The precise locations of these wells will be finalized following completion of a supplemental groundwater investigation involving collection of groundwater samples using Hydropunch technology. The Hydropunch program will be used to assess whether groundwater is completely discharged at the Site 35 seep area or a portion of it flows south toward the spring. To accomplish this objective, up to six Hydropunch locations will be completed as temporary piezometers. Along with installation of injection and monitoring wells, the study will involve a benchscale test, initial sampling of monitoring wells to establish pre-treatment (baseline) conditions, initial injection of the soybean oil substrate into injection wells, and sampling of selected monitoring wells at quarterly intervals over a 12-month test period. The total duration of the Treatability Study is anticipated to be approximately 18 months.

Tetra Tech will prepare and submit four quarterly technical memoranda containing all data collected during the IRA and Treatability Study. The reports will include a description of field activities, photographic documentation, analytical data, and recommendations. The first quarterly report will include both the baseline monitoring at Sites 32 and 35 and the first quarterly sampling event, a summary of the benchscale testing, and a summary of the implementation of the Site 32 phytoremediation IRA and Site 35 Treatability Study. The final quarterly report will be comprehensive report including a summary of all activities conducted for the entire Treatability Study and IRA, and any recommendations.

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1.0 INTRODUCTION

The Air Force contracted Tetra Tech, Inc. (Tetra Tech) to perform an Interim Removal Action (IRA) and a Treatability Study at Installation Restoration Program (IRP) Sites 32 and 35, respectively, at Vandenberg Air Force Base (AFB), Santa Barbara County, California. This Removal Action Work Plan (RAW) presents the proposed IRA approach for Site 32 and includes a detailed work plan for the Treatability Study to be implemented at Site 35

Environmental investigations conducted at Sites 32 and 35 indicate that previous missile launch activities at Missile Silo 576-D (Site 32) and 576-G (Site 35) have impacted groundwater quality in two distinct areas. These areas, identified as plumes, are located west and downgradient of the missile silos. Groundwater modeling results indicate that natural attenuation processes alone are not sufficient to reduce trichloroethene (TCE), *cis*-1,2-dichloroethene (*cis*-1,2-DCE), and vinyl chloride levels below their respective remediation goals within a reasonable timeframe. For example, the U.S. Environmental Protection Agency (U.S. EPA) recognizes that determination of what timeframe is "reasonable" for attaining remediation objectives is site-specific. The U.S. EPA suggests that a reasonable timeframe for a remedy relying on natural attenuation is generally a "…timeframe comparable to that which could be achieved through active restoration" (U.S. EPA 2002).

This RAW evaluates various removal action alternatives to address cleanup of TCE at the leading edge of the Site 32 groundwater plume, selects the preferred alternative, and describes the basis, scope, and methodology for implementation of the selected alternative. In addition, Tetra Tech recommends conducting a Treatability Study to evaluate the effectiveness of soybean oil to treat TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, and vinyl chloride dissolved in groundwater downgradient from Missile Silo 576-G, near well 35-MW-8 at Site 35. The Treatability Study objectives are to provide sufficient data to allow this treatment alternative to be fully developed and evaluated during the detailed analyses and to support the remedial design of a selected alternative at Site 35.

1.1 PURPOSE OF REMOVAL ACTION WORK PLAN

The RAW describes the work that will be performed to mitigate the exposure pathway for receptors of volatile organic compounds (VOCs) in the groundwater at the Site 32 spring. This non time-critical removal action will adhere to the following approach:

- Evaluate remedial alternatives;
- Screen and select a technology based on effectiveness, implementability, and cost; and
- Describe the basis, scope, and methodology of the removal action technology.

1.2 RESPONSIBILITIES OF PARTIES INVOLVED

The Air Force is responsible for implementing the approved RAW, and Tetra Tech is responsible for preparing and submitting the RAW on behalf of the Air Force. Section 25356.1 (b) of the California Health and Safety Code requires the Department of Toxic Substances Control (DTSC) or, if appropriate, the Regional Water Quality Control Board (RWQCB) to approve the RAW for sites subject to Section 253566. For the proposed Site 32 IRA and Site 35 Treatability Study, DTSC is serving as the lead regulatory agency.

1.3 ORGANIZATION OF THIS REMOVAL ACTION WORK PLAN

The RAW is divided into nine sections, including this section. The sections are as follows:

- Section 1: Introduction
- Section 2: Site Description and Environmental Setting
- Section 3: Investigation Results
- Section 4: Summary of Site Risks
- Section 5: Evaluation of Remedial Alternatives
- Section 6: Removal Action Implementation
- Section 7: Residuals Management
- Section 8: Quality Assurance Project Plan Addendum
- Section 9: Public Involvement
- Section 10: References
- Section 11: Acronyms and Abbreviations

The RAW also includes the following appendices:

- Appendix A: Sites 32 and 35 Administrative Record List
- Appendix B: Applicable or Relevant and Appropriate Requirements (ARARs)
- Appendix C: Health and Safety Plan Addendum
- Appendix D: Removal Action Alternative Costing Support
- Appendix E: Response to State Regulatory Comments

1.4 PROJECT SCHEDULE

The schedule for implementing the proposed removal action at Site 32 and the Treatability Study at Site 35, including preparation and review of this RAW, is presented in Table 1.4-1.

2.0 SITE DESCRIPTION AND ENVIRONMENTAL SETTING

This section presents site description and environmental setting information for Vandenberg AFB and IRP Sites 32 and 35.

2.1 SITE DESCRIPTION

2.1.1 Site Vicinity and Land Use

Sites 32 and 35 are located on San Antonio Terrace in the northern part of Vandenberg AFB between El Rancho Road and El Rancho Oeste Road, approximately 6 miles north of the main cantonment area (Figure 2.1-1). The city of Lompoc (population 37,649) is 13 miles southeast of the site and the city of Santa Maria (population of 70,811) is 8 miles north of the site.

Site 32 and Site 35 are treated as a "site cluster" due to their shared biologic, geologic, and hydrogeologic settings, as well as their similar designs and linked operational history. The two sites share a common boundary composed of sections of Astral Road and Astro Road (unpaved section). Both sites were constructed and used for launching Atlas missiles.

Site 32 facilities include one missile silo, a control center, a former waste disposal area, and three drainage channels for directing storm water (designated here as Channels 32A, 32B, and 32C). A chain-link fence topped with barbed wire encloses the silo compound. The waste disposal area is primarily composed of crushed Sisquoc Formation shale bedrock excavated during construction of the silos at Sites 32 and 35

Site 35 facilities include a missile silo, a control center, an instrument building, and a utility building. The site facilities are surrounded by a barbed-wire fence. Four concrete-lined drainage channels (designated here as Channels 35A, 35B, 35C, and 35D) and one unlined channel direct runoff away from the silo facility and control center (Figure 2.1-2).

Raytheon used Site 32 as an active radar facility through September 1999. Future plans for Site 32 are unclear at this time; however, this site may be used as an active launch support facility. Current uses of Site 35 include equipment storage and office work. Planned use of the land surrounding Sites 32 and 35 includes open space and grazing pasture for cattle.

2.1.2 History of Operations

Two Atlas missiles were launched from the Site 32 facility. The Atlas missiles were fueled with a combination of Rocket Propellant No.1 (a petroleum hydrocarbon–based fuel similar to kerosene) and liquid oxygen (LOX) and did not use hydrazine as a fuel source. These Atlas launches occurred in 1963 and 1964. Dames and Moore (1993) and U.S. Air Force (1993) reports indicate that Atlas F missiles and dry pad technology were used during launches from Site 32. The silo facility at Site 32 served primarily as a training facility for actual operations at Site 35.

Seven Atlas missiles were launched from the Site 35 facility. These launches occurred in 1962, 1963, 1964, and 1965. Battelle Corporation (Battelle 1986), Dames & Moore (1993), and U.S. Air Force (1993) indicate the silo facility was an Atlas F facility and therefore used "dry pad" technology for launches.

Dry pad launch facilities typically generated wastes during missile launches, such as TCE, mixed solvents, lubrication oils, and hydraulic fluids (Reynolds, Smith, and Hill, Inc. [Reynolds] 1985). These types of wastes were likely generated at Sites 32 and 35. Launches are not currently conducted at either site and are not planned in the future.

2.2 ENVIRONMENTAL SETTING

2.2.1 Climate

The climate at Vandenberg AFB near Sites 32 and 35 remains relatively mild and constant throughout the year. The prevailing wind direction is from the west and northwest. The climate is categorized as subtropical (Mediterranean), receiving modest precipitation during the winter months (December through March), and little or no precipitation the rest of the year.

The Vandenberg AFB 30th Weather Squadron compiles climatic data at various sites on-base, including the Base Airfield, which is geographically similar to Sites 32 and 35 in its altitude and distance from the Pacific Ocean. From 1952 through 1997, the annual rainfall at the airfield ranged from 4.00 inches to 28.40 inches, with an average of 14.16 inches per year. During California's recent drought period (1984 through 1990), the annual rainfall at the airfield averaged 9.93 inches. In 1995, 1996, and 1998 Vandenberg AFB received above average precipitation. The average annual temperature at the airfield, based on data compiled from 1952 to 1997, is 57 degrees Fahrenheit (F). Recorded temperature extremes from 1952 through 1998 are a low of 25 degrees F and a high of 100 degrees F.

2.2.2 Regional Population Estimates

Vandenberg AFB supports approximately 12,000 personnel, comprising Air Force personnel and their dependents, civilian employees, and contractors. Approximately 2,080 family housing units are located 3.5 miles south of Sites 32 and 35 in the main cantonment area. The cities of Lompoc and Santa Maria, each more than 10 miles from the site, have populations of 41,103 and 77,423, respectively (U.S. Census Bureau 2000).

Both Site 32 and Site 35 once supported numerous on-site workers when the launch facilities were fully active. The radar facility at Site 32 was removed in 1999 and workers are no longer present at the site on a daily basis. The only current on-site occupants of Site 35 are in Building 1930 (Moore 1998). Three divisions of the missile refurbishment squadron occupy Building 1930: (1) Corrosion Division, (2) Refurbishing Division, and (3) Equipment/Cranes Division. Each of these divisions performs its primary duties at facilities elsewhere on base. Building 1930 is primarily a staging facility

2.2.3 Geology, Topography, and Soils

Sites 32 and 35 are located on the northeast margin of the San Antonio Terrace, a broad flat platform formed in Pleistocene time. The stratigraphy of the sites includes Pleistocene Orcutt Formation sediments at the surface deposited unconformably on late Miocene Sisquoc Formation shale and mudstone.

The Orcutt Formation consists of loosely consolidated lenticular beds of sand, gravel, and clay of predominantly continental origin, with the upper zone representing eolian and beach sand (Science Applications International Corporation [SAIC] 1990).

Bedrock beneath Sites 32 and 35 consists of Sisquoc Formation, which comprises "white to cream-white punky laminated diatomite and diatomaceous mudstone or shale interlayered with light gray diatomaceous claystone and shale" (Dibblee 1989). Bedrock bedding planes strike north-northwest and dip to the southwest, approximately parallel to the topographic slope.

Topography within the combined Site 32 and Site 35 boundary slopes gently to the southwest toward El Rancho Oeste Road from El Rancho Road. Topographic elevation across Sites 32 and 35 varies from approximately 520 feet above mean sea level (msl) at the northeast boundary to approximately 290 feet above msl at the southwest. The average slope is 0.06 feet per foot.

Soils at Sites 32 and 35 consist of Tangair and Narlon type sands. Highly permeable Tangair type sands are found on the northeastern two-thirds of Sites 32 and 35, while low permeability Narlon type sands are found on the southwestern third (Shipman 1972). Geologic cross sections of Sites 32 and 35 are shown on Figures 2.2-1 and 2.2-2, respectively

2.2.4 Hydrology

Groundwater at the sites flows to the southwest following the bedrock topography at a gradient of 0.05 feet per foot. Groundwater is unconfined and the depth to groundwater varies from approximately 50 feet below ground surface along the eastern boundary of the sites in 32-MW-1 to ground surface at a spring in the southwest portion of Site 32.

The spring, located just south of the intersection of El Rancho Oeste Road with Astro Road, and the cattle pond south of the spring, are the only perennial surface water features at Sites 32 and 35. Discharge from the spring ranges from approximately 2 to 10 gallons per minute, depending on levels of precipitation and flows to a small, shallow area to the southwest (U.S. Air Force, 2004a). Although this area has been known to go dry, moist soils and shallow standing water (1 to 24 inches) have been observed. The cattle pond contains water year-round, but varies in size seasonally—from completely dry to as large as 75 by 25 feet.

The seeps at Site 35 are located near monitoring well 35-MW-8 and flow intermittently. During years with average and below average precipitation, the seep area is dry. The seeps occur only during years of high precipitation, such as during the winter of 1998, when groundwater levels rise and groundwater discharges to the surface. Immediately after the construction of monitoring well 35-MW-8 in February 1998, the static water level in the well casing reached the ground surface, exhibiting artesian characteristics. According to the bedrock contour illustrated in Figure 2.2-3, the Sisquoc Formation bedrock meets the potentiometric surface in the vicinity of the seep area. The temporal artesian characteristics exhibited by 35-MW-8 indicate the influence of shallow bedrock and potential confining layers on groundwater occurrence

During the remedial investigation (RI), measurements of hydraulic conductivity were collected from geotechnical sample analyses, well purge observations and slug testing. These measurements were evaluated to derive an average, representative hydraulic conductivity for the sites, since individual test data ranged over an order of magnitude or more. Slug test and purge record data were considered to yield the most representative hydraulic conductivity values. At Site 32, hydraulic conductivity values ranged from 0.4 foot/day to 7.3 feet/day; at Site 35, hydraulic conductivity values ranged from 0.17 foot/day to 11.4 feet/day. Groundwater seepage velocity, calculated with a groundwater model calibrated hydraulic conductivity of 2 feet/day, a hydraulic gradient of 0.05, and an effective porosity of 0.226 is 0.44 foot/day or 161 feet/yr (U.S. Air Force, 2004a). Groundwater equipotential contours at Sites 32 and 35 from winter 2004 are shown on Figure 2.2-4.

2.2.5 Ecological Resources

The area surrounding Sites 32 and 35 is dominated by annual grassland scrub habitat The annual grassland habitat surrounding Sites 32 and 35 is used as grazing pastures for cattle. The low-growing annual grassland plants provide little cover and few nesting sites for wildlife As a result, resident animals tend to be ground-nesting or burrow-dwelling species

There is a freshwater spring and a cattle pond at Site 32, and intermittent groundwater seeps at Site 35. These areas are discussed in the section on wetlands.

2.2.6 Wetlands

A freshwater spring is located in the southwest corner of Site 32, just west of El Rancho Oeste Road No emergent/aquatic vegetation has been observed at this spring; much of the vegetation at this spring is similar to the surrounding annual grasslands. Discharge from the spring flows to a small, shallow area to the southwest that supports cattails, rushes, and a small willow thicket.

A pond was excavated in the hillside just south-southwest of the spring for the purpose of providing drinking water to cattle. The area immediately surrounding this perennial pond is heavily trampled by cattle. California red-legged frogs were observed in the pond in 1995 and in 1997 (Christopher 1997); however, no other amphibians or reptiles of regulatory concern were observed at Sites 32 or 35. The freshwater spring and cattle pond are the only perennial surface water features at Sites 32 and 35.

Damp soils and hoof prints in areas southwest of El Rancho Oeste Road, downslope from the Site 35 silo facilities, suggest that groundwater may discharge to the surface. No surface water (other than small, intermittent puddles) and no freshwater aquatic/emergent vegetation has been observed in this area during site investigations. This area near monitoring well 35-MW-8 is dominated by annual grassland vegetation that is characteristic of areas surrounding Sites 32 and 35.

2.2.7 Cultural Resources

The Cultural Resources Section of the, 30th Civil Engineer Squadron Environmental Flight (CES/CEVPC) was contacted in 2001 to determine if cultural resources were identified at Site 35. Cultural resources and historic buildings will be identified during the completion of a Form 35 prior to implementing any site activities at Sites 32 and 35. It is expected that the proposed activities would not impact either cultural resources or historic buildings at Sites 32 and 35.

3.0 INVESTIGATION RESULTS

Previous investigations at Sites 32 and 35 included environmental sampling, soil gas surveys, geophysical surveys, geotechnical surveys, literature reviews, and personal interviews. Environmental sampling indicated the presence of metals above established background threshold values (BTVs); solvents (TCE and its breakdown products); benzene, toluene, ethylbenzene, and xylene (BTEX); and cycloalkanes/alkenes in the soil and groundwater at Sites 32 and 35. Reynolds (1985), Battelle (1986), SAIC (1990), Dames and Moore, Jacobs Engineering Group (JEG 1992), and Tetra Tech all conducted site investigations at Site 32 and/or Site 35 These are summarized in the *Draft Final Remedial Investigation Report for Sites 32 and 35* (U.S. Air Force 2004a).

3.1 RECORDS SEARCH AND RECONNAISSANCE VISITS

Tetra Tech conducted a records search, combined with interviews of civilian and military personnel, to clarify primary source areas, release mechanisms, and potential site contaminants at Sites 32 and 35. The review indicated that primary source areas included the Site 32 and 35 silo facilities and the waste dump. The primary release mechanisms at each silo facility involved pre-launch, launch, and post-launch activities; potential leakage from underground storage tanks (USTs); and potential leaching from the waste dump

On 28 April 1993, 26 May 1994, and 14 September 1994, Tetra Tech performed a phased reconnaissance of the Site 32 silo facility. Site reconnaissance involved inspecting the site for evidence of potential primary release areas, conducting an on-site review of release mechanisms, and looking for potential secondary release areas. The site conditions described in the Phase I RI work plan (JEG 1993a) were compared to observed site conditions. The Site 32 reconnaissance identified Site 35 waste dump area debris and evidence of two USTs having been present.

On 28 April 1993 and 8 March 1995, Tetra Tech surveyed the Site 35 silo facility. The 8 March 1995 effort was to observe site conditions following a very rainy winter season. Site reconnaissance involved inspecting for evidence of potential primary release areas, conducting an on-site review of release mechanisms, and inspecting for secondary release areas. The site conditions described by JEG (1993a) were compared to observed site conditions. The Site 35 reconnaissance identified no signs of potential contamination, with the exception of the minor soil staining and sand grit near Building 1930.

3.2 TETRA TECH FIELD INVESTIGATIONS

Tetra Tech assumed responsibility for the RI at Sites 32 and 35 in spring 1993. The work performed as part of the RI is separated into preliminary activities, investigative activities, and baseline risk assessment. Information gained during the preliminary activities was used to modify the investigative activities, for example, monitoring well relocation. Work performed as part of the RI included military and civilian personnel interviews and record searches of available reports and engineering drawings; site reconnaissances to assess source areas, previous sampling locations, and the appropriateness of the proposed sampling locations; mapping of the spatial distribution and orientation of bedrock bedding planes, erosional surfaces, fractures, joints, and faults; completion of a soil gas survey; completion of a geophysical survey; installation of groundwater monitoring wells; and collection and analysis of sediment samples, soil boring samples, surface water samples, and groundwater samples. The groundwater sampling results are summarized herein.

Table 3.2-1 and Figure 3.2-2 provide summaries of chlorinated VOCs detected in groundwater during all Tetra Tech sampling investigations.

3.2.1 Phase I Groundwater Sampling Results

During Phase I of the RI, groundwater from Site 32 was collected from boring 32-J-B-2 and from monitoring wells 32-MW-1 through 32-MW-5. Detected VOCs included methylene chloride, methyl ethyl ketone, TCE, and *cis*-1,2-DCE. The concentration of *cis*-1,2-DCE detected at well 32-MW-2 was 7.19 micrograms per liter (μg/L), which is above the California maximum contaminant level (MCL) of 6 μg/L; TCE was detected above the California MCL of 5 μg/L in well 32-MW-3 at a concentration of 7.26 μg/L. All other detected VOCs were below MCLs.

During Phase I of the RI, groundwater from Site 35 was collected from wells 35-MW-1 through 35-MW-4. TCE was detected at a concentration of 0.681 μg/L in well 35-MW-4.

3.2.2 Phase II Groundwater Sampling Results

During the Phase II investigation, groundwater was collected and analyzed from borings 32-B-7 through 32-B-10 and from wells 32-MW-1 through 32-MW-7. VOCs detected were TCE, acetone, 2-butanone, 1,1-dichloroethane (DCA), 1,1-DCE, *cis*-1,2-DCE, and *trans*-1,2-DCE. TCE was the only VOC detected at concentrations exceeding the California MCL of 5 μg/L. Metals detected above BTVs included arsenic, barium, cadmium, chromium, cobalt, and nickel.

Selected monitoring wells were also tested for monitored natural attenuation (MNA) parameters. Results of these tests suggest aerobic aquifer conditions as evidenced by dissolved oxygen (DO) values ranging from 3.9 to 8.2 milligrams per liter (mg/L), and oxidation-reduction potential (ORP) ranging from 32 to 141 millivolts, with low concentrations of ferrous iron (0 to 0.6 mg/L) detected in selected wells.

Phase II groundwater samples were collected from hollow-stem auger boring 35-B-9 (20 and 39 feet below grade), direct push borings 35-P-1 through 35-P-9, and wells 35-MW-1 through 35-MW-9. Detected chlorinated VOCs included TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, 1,1-DCE, tetrachloroethene (PCE), 1,1,1-trichloroethane (TCA), and 1,1,2-TCA. The highest detected concentrations were found in the 39-foot grab sample from 35-B-9, where TCE was detected at a concentration of 6,200 μg/L, and *cis*-1,2-DCE was detected at 88 μg/L. Monitoring well 35-MW-7 was later installed adjacent to location 35-P-9. TCE was detected at a concentration of 270 μg/L and *cis*-1,2-DCE was detected at 160 μg/L in well 35-MW-7. Phase I and Phase II analytical results for chlorinated solvent compounds are shown on Figure 3.2-1, in addition to winter 2003 data from the Basewide Groundwater Monitoring Program (BGMP).

3.2.3 BGMP Groundwater Sampling Results

Groundwater monitoring at Sites 32 and 35 has continued through the BGMP since fall 1999. Under this program, wells at both sites are monitored semiannually. Analytical data from the BGMP at Sites 32 and 35 are summarized in Figure 3.2-2.

Groundwater at Site 32 is characterized by relatively low TCE concentrations (the maximum concentration 13.4 μg/L was detected in winter 2004) forming an ellipsoidal plume covering an area approximately 1,500 feet long by 500 feet wide, downgradient from the missile silo (Figure 3.2-2). A cross section of the plume is shown on Figure 2.2-1. The BGMP data for Site 32 indicate TCE concentrations in the plume appear to be decreasing slowly. The TCE concentration in the source location, 32-MW-7, has decreased from 46 μg/L (summer 2000) to 13.4 μg/L (winter 2004). Concentrations in the other plume wells 32-MW-2 and 32-MW-3 have been decreasing since summer 2002, with recent concentrations at the downgradient edge at 8.8 μg/L (winter 2004). From fall 1999 to winter 2004, low concentrations of TCE (1.2 to 3.4 µg/L) have been consistently detected in surface water samples from the spring at 32J-SW-1.

No dense non-aqueous phase liquids (DNAPLs) have been detected during any of the field investigations at Site 32. Measured concentrations in soil and groundwater are below levels that suggest the presence of TCE or *cis*-1,2-DCE as a DNAPL.

Metals in groundwater that exceed BTVs that have higher toxicity values include chromium, cobalt, manganese, nickel, selenium, and silver. From the winter 2004 monitoring data, only silver was detected at a concentration greater than 5 times its BTV (4.0 to 8.6 µg/L in wells 32-MW-2 through 32-MW-7 and surface water location 32J-SW-1). Metals in groundwater that exceed California primary MCLs include chromium (86 µg/L in well 32-MW-3) and nickel (366 µg/L and 942 µg/L in wells 32-MW-1 and 32-MW-3, respectively). The presence of these metals in groundwater is interpreted to be sourced from the steel casing material used by SAIC to construct the wells in 1987.

The Site 35 groundwater plume is elongated in the direction of groundwater flow and is characterized by monitoring wells 35-MW-7 and 35-MW-8, forming an ellipsoidal plume approximately 1,100 feet by 375 feet (Figure 3.2-2). A cross section of the plume at Site 35 is shown in Figure 2.2-2. From fall 1999 to winter 2004, relatively stable TCE concentrations in the Site 35 groundwater plume remained except for well 35-MW-7, where they have recently begun to decrease. Groundwater from well 35-MW-7, located in the plume source area, has had TCE concentrations ranging from 960 µg/L in spring 2001 to a low of 199 µg/L in winter 2004. The recent decline in TCE concentration is attributed to an in-situ reactive zone (IRZ) technology demonstration program (see next section) that has been ongoing near well 35-MW-7 since 1999. TCE concentrations in the downgradient well 35-MW-8 have ranged from a low of 590 µg/L in fall 2002 to a high of 1,200 µg/L in winter 2002; most recently (winter 2004) it was 928 µg/L. TCE has either not been detected, or has been sporadically detected at concentrations well below the MCL of 5 µg/L in other Site 35 wells monitored under the BGMP.

Groundwater concentrations of *cis*-1,2-DCE in the Site 35 plume have also exhibited relative stability, with the exception of recent increases at well 35-MW-7. Concentrations of *cis*-1,2-DCE in groundwater have been highest at well 35-MW-7, ranging from 10 µg/L in winter 2001 to a high of 160 µg/L in winter 2003; most recently (winter 2004) it was 48.9 µg/L. The increase in *cis*-1,2-DCE at this well, accompanied by a decrease in TCE in the same well, is consistent with an interpretation of in-situ reductive dechlorination caused by the IRZ demonstration program (see next section). At other Site 35 wells, concentrations of *cis*-1,2-DCE have ranged from below detection up to a high of 9.4 µg/L in well 35-MW-8 in spring 2001. The compound *trans*-1,2-DCE has been reported in well 35-MW-8 only at low concentrations (0.56 to 0.92 µg/L), and has not been detected since winter 2000.

Vinyl chloride has recently (winter 2004) been detected in well 35-MW-7 at 19 µg/L. Its presence is interpreted as sequential breakdown of TCE and *cis*-1,2-DCE, resulting from the IRZ demonstration program near well 35-MW-7

Groundwater from monitoring well 35-MW-9, located downgradient and downslope from well 35-MW-8, has never contained TCE in excess of the MCL. This well has been dry since fall 2001 with the exception of winter 2005. However, data has not yet been procured for the winter 2005 sampling round.

No DNAPLs have been detected during any of the field investigations at Site 35. Measured concentrations in soil and groundwater are below levels that would suggest the presence of TCE as DNAPL. However, the detection of TCE at a concentration of 6,200 µg/L in boring 35-B-9 did reportedly occur at the bottom of the saturated zone.

Metals that were detected in excess of BTVs during winter 2004 at Site 35 include chromium (35-MW-1), iron (35-MW-2), selenium (35-MW-8), and silver (35-MW-1 through 35-MW-4). Only nickel was detected at a concentration that exceeded the California primary MCL (444 µg/L in well 35-MW-1). Its presence is also attributed to the stainless steel casing used by SAIC for the well construction in 1987

3.3 IN-SITU REACTIVE ZONE DEMONSTRATION PROJECT

ARCADIS has been conducting an IRZ demonstration project at Site 35 since 1999. The demonstration project involves the injection of nutrients (molasses) to stimulate biodegradation of TCE in groundwater. To support this program, a total of three injection wells, four piezometers, 11 monitoring wells, and one Hydropunch boring have been installed and sampled, all located within approximately 90 feet both upgradient and downgradient of well 35-MW-7 (Figure 3.4-1). In addition, four Hydrosparge samples were collected and analyzed for specific VOCs.

During the IRZ baseline sampling round between September and November 2000, Hydrosparge samples analyzed for TCE indicated elevated concentrations in an area not previously identified as part of the TCE plume on Site 35. Analytical results of Hydrosparge samples collected from locations 35-H-1B and 35-H-1C indicated the presence of TCE at concentrations of 1,000 µg/L and 5,000 µg/L, respectively. These locations are approximately in a line between the two monitoring wells, 35-MW-1 and 35-MW-6, which mark the ends of drainage channels B and D. The TCE concentrations (1,000 and 5,000 µg/L) are more similar to Phase I direct push data from 35-B-9 (6,200 µg/L). These data supplement the data from a direct push boring, 35-P-5, located approximately 100 feet downgradient, which had a detected TCE concentration of 360 µg/L at the bottom of the saturated zone. These locations and data elongate the Site 35 plume nearer to the missile silo, the suspected primary source of TCE (Figure 3.3-1).

Following the baseline monitoring event, molasses was injected in February 2001 at the three injection wells. A conservative tracer (bromide) was added to the molasses to assist in tracking its movement within groundwater downgradient from the injection well array. As of May 2003, a total of 31 injection events have been performed, along with six full monitoring events and 26 process monitoring events. Due to an initial lowering of pH following molasses injections, the contractor began introducing a buffering agent (sodium bicarbonate) in October 2002. Interim findings from the IRZ program indicate a clear zonation of ORP in groundwater with the most reducing conditions (methanogenesis) prevalent nearest the injection well array, and progressively more oxidizing conditions (i.e., sulfate reduction, iron reduction) indicated with increasing distance from the injection well network.

Table 3.4-1 summarizes the IRZ demonstration program sampling events for TCE, *cis*-1,2-DCE, and vinyl chloride from November 2000 through May 2003. Notable ARCADIS wells that demonstrate TCE presence above 1,000 µg/L at least once following baseline monitoring include wells 35-MW-12, 35-MW-15, 35-MW-16, 35-MW-17, and 35-MW-19A. Over the course of the demonstration project, TCE was shown to decline in each of these wells; accompanied by a presence or increase in *cis*-1,2-DCE. In wells 35-MW-16 and 35-MW-19A, *cis*-1,2-DCE concentrations increased from a low of 18 to a high of 450 µg/L, and from 38 to 250 µg/L, respectively, over the course of the demonstration program. Vinyl chloride was detected from three wells in the May 2003 sampling event only at concentrations ranging from 0.28J to 26 µg/L (Table 3.4-1).

Using well 35-MW-16 as an example, the change in TCE concentration between baseline sampling in November 2000 (1,600 µg/L) and the end of project sampling in May 2003 (410 µg/L), represents a decline in 1,190 µg/L. On a stoichiometric basis, expressed in molar equivalents, a change in TCE of 1,190 µg/L represents 9.06 micromoles TCE per liter (µM TCE/L). *Cis*-1,2-DCE increased in the same well over the course of the project by 419 μg/L; which equates to a molar equivalent of 4.32 μM DCE/L. For vinyl chloride, a single detection of 26 μg/L at the end of the study would correspond to a molar equivalent of 0.42 μM VC/L. Ethene did not change significantly over the source of the study in this well. Thus, a little over one half of the TCE decline in well 35-MW-16 can be associated with a rise in DCE and VC over the course of the study.

3.4 PREVIOUS REMOVAL ACTIONS

A soil removal action encompassing excavation and removal of near surface soil was performed at Site 35. The baseline human health risk assessment published in the Draft RI Report for Sites 32 and 35 (U.S. Air Force 1999a) indicated that surface and subsurface soils next to Channel C and Astral Road contain polychlorinated biphenyl (PCB) 1260 at levels posing a potential risk to workers at Site 35. A RAW was prepared by Tetra Tech in July 2001 that outlined the engineering plans for removing the PCB-contaminated soil. Implementation of the RAW in August 2001 resulted in excavation, removal, proper off-site disposal of the PCB-contaminated soils, confirmation sampling, and site restoration. A closure report was submitted on 17 October 2001 to the DTSC and RWQCB with details of the excavation and removal (U.S. Air Force 2001).

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4.0 SUMMARY OF SITE RISKS

This section summarizes the human health and ecological risks associated with chlorinated solvent–contamination present at Sites 32 and 35. As discussed in the following sections, overall, there are no adverse non-carcinogenic health effects that would be experienced by receptors at Sites 32 and 35 exposed to soils, sediments, surface water, and airborne constituents. The potable use of groundwater at Sites 32 and 35 could result in adverse non-carcinogenic health effects for current and future conditions in the Site 32 plume but only for current conditions in the Site 35 plume. There are, however, no plans to use the groundwater at Sites 32 and 35 for potable purposes in the future. These risks are based on a conceptual site model as well as the source and extent of contamination. Based upon the conceptual site model and risks drawn from that model, removal action cleanup goals are established and discussed in this section.

4.1 CONCEPTUAL SITE MODEL

Sources of contamination, release mechanisms, migration pathways, exposure routes, and potential receptors, as they relate to the downgradient extent of dissolved phase groundwater contamination, are described in this section. Sites 32 and 35 are addressed together in this section. A Conceptual Site Model (CSM) diagram illustrating sources, pathways, and receptor locations is presented in Figure 4.1-1 for Site 32 and 35.

4.1.1 Source and Extent of Groundwater Contamination

Sources of contamination at Sites 32 and 35 are likely associated with past operations at the silo facilities. Contaminants may have been released into the environment at the silo facilities during painting and sandblasting activities, pre-launch degreasing of the Atlas rocket engines, launch activities, and leakage related to storage of chemicals. During missile launches, dry pad launch facilities typically generated wastes, such as TCE, mixed solvents, lubrication oils, and hydraulic fluids (Reynolds 1985).

The Site 32 groundwater plume is narrow and contains relatively low concentrations of TCE contamination. The plume starts at the silo facilities and runs southwest to El Rancho Oeste Road. Its extent, based on the 5 µg/L MCL for TCE, is estimated at approximately 1,500 feet in length and 500 feet in width (Figure 3.3-1). The highest TCE concentrations have been detected in well 32-MW-7, which is located downgradient of the Channel C discharge point and is screened at the bottom of the saturated zone. From the Phase I investigation through winter 2004 of the BGMP, TCE concentrations have steadily decreased at well 32-MW-7. TCE has historically been detected at concentrations above the MCL of 5 µg/L in downgradient plume wells 32-MW-2 and 32-MW-3. At well 32-MW-2, TCE concentrations increased from winter 1994 to winter 2002, when they peaked; however, since winter 2002, concentrations have fluctuated between 8.4 and 26 µg/L. At well 32-MW-3, TCE concentrations have fluctuated between 1.4 and 15 µg/L. A trend analysis performed on all sampling events indicates statistically decreasing trends at 32-MW-7; statistically increasing trends at 32-MW-3, and probable increasing trends at 32-MW-2 (U.S. Air Force 2000b). This supports the view that the plume is slowly moving downgradient.

The Site 35 groundwater plume is elongated in the direction of groundwater flow, and is characterized by monitoring wells 35-MW-7 and 35-MW-8, forming an ellipse approximately 1,100 feet in length by 375 feet in width. Groundwater at Site 35 is characterized by moderate TCE concentrations ranging from 199 to 928 µg/L (winter 2004) of TCE in plume wells 35-MW-7 and 35-MW-8, with concentrations of *cis*-1,2-DCE between 5 and 49 µg/L. Recently, vinyl chloride has been detected in well 35-MW-7 at concentrations between 15 and 18.8 µg/L. This degradation of TCE and formation of first and second generation degradation products, *cis*-1,2-DCE and vinyl chloride, are attributed to the IRZ demonstration project near well 35-MW-7

Nineteen additional monitoring wells/points (Figure 3.4-1) have been installed by ARCADIS in support of their demonstration project These wells are positioned in the vicinity of well 35-MW-7 Historic groundwater monitoring data from these wells are summarized in Table 3 4-1. Review of this table indicates that TCE and its degradation daughter products *cis*-1,2-DCE and vinyl chloride have been detected in selected ARCADIS monitoring wells. It is noted that due to differences in sampling techniques used by ARCADIS (e.g. Hydrosparge grab samples, submersible pumps, etc.) compared to methods employed during the BGMP (i.e. MicroPurge Sampling), as well as temporal differences in sampling dates, there exists some difference in VOC concentrations reported between the ARCADIS data, particularly for well 35-MW-7 (Table 3 4-1), and the BGMP reported data (Figure 3.2-2)

The baseline monitoring event completed by ARCADIS in November 2000 was characterized by relatively high detection limits for *cis*-1,2-DCE and vinyl chloride rendering comparison of subsequent monitoring data against baseline data to be somewhat limited. Also, approximately one half of ARCADIS' monitoring points were grab samples, where only a single data point is available; these data were presumably used to fine tune positioning of permanent monitoring wells. Collectively, the ARCADIS data provides additional documentation of chlorinated VOC presence in groundwater near well 35-MW-7, but do not demonstrate a significantly larger groundwater plume

Uncertainties exist regarding the CSM for Sites 32 and 35, including the extent of the existing plume and the potential rate-limited desorption behavior of the VOCs in the Site 35 plume. As previously discussed in Section 3.4, Hydrosparge data results (i.e., 35-H-1B and 35-H-1C) from the IRZ demonstration project (ARCADIS 2003) contradict the data from a direct push boring, 35-P-5, located approximately 100 feet downgradient, which had a detected TCE concentration of 360 µg/L at the bottom of the saturated zone. These locations and data would potentially elongate the high concentration secondary source area of the Site 35 plume nearer to the silo, the primary source of TCE. An uncertainty also exists due to the potential of groundwater flow direction to the south in the vicinity of 35-MW-8. The nature and extent of the plume may change as elevated concentrations of TCE and its daughter products pass through this area, characterized by local bedrock highs, dry wells to the west, and temporal artesian conditions.

4.1.2 Groundwater Modeling Summary

Groundwater modeling was performed as part of the RI and is presented in the Draft Final RI Report (U.S. Air Force 2004a) The objective of the groundwater modeling is to provide predicted future groundwater concentrations at the surface discharge areas, which are the perennial spring at Site 32 and intermittent seeps downgradient of El Rancho Oeste Road at Site 35 These represent the future surface water exposure point concentrations to be evaluated for potential human health and ecological impacts. The modeling also quantitatively demonstrates the impacts of attenuation processes (i.e., advection, dispersion, degradation) on the future evolution of the TCE and 1,2-DCE groundwater plumes. The groundwater model presented in the Draft Final RI Report was calibrated to spring 1998 data, and the prediction model simulated, based on winter 2003 data, initial conditions supplemented with the most recent data for wells not sampled in winter 2003.

Groundwater flow at Sites 32 and 35 was modeled using the U.S. Geological Survey (USGS) MODFLOW model Groundwater fate and transport was simulated using the Modular Three Dimensional Transport Model (MT3D) model and the Multi-Species Reactive Transport Simulation Software (RT3D) model. Conservative assumptions were made when estimates were required in the absence of site-specific input data Calibrations and sensitivity runs were routinely performed for optimization of the model results.

Site 32 Plume

Predicted maximum concentrations at the Site 32 spring would reach 12.5 and 0 04 μg/L for TCE and *cis*-1,2-DCE, respectively, for the baseline scenario. Based on a simulation starting time of winter 2003, the estimated migration times for these levels of TCE and *cis*-1,2-DCE to the spring at Site 32 are 8 and 4 years, respectively, discharging at the spring around the years 2011 and 2007, respectively. Groundwater concentrations at the Site 32 spring are predicted to reach 14 5 and 3.5 μg/L for TCE and *cis*-1,2-DCE, respectively, for the high-end sensitivity analysis range. At the low end of the sensitivity range, predicted concentrations of TCE and *cis*-1,2-DCE would reach 4 0 and 0.03 μg/L, respectively, at Site 32. Although vinyl chloride has not been detected, if degradation of *cis*-1,2-DCE to vinyl chloride occurs, then predicted concentrations at the Site 32 surface discharge areas could potentially reach 1.6 μg/L (U.S. Air Force 2004).

Site 35 Plume

At Site 35, predicted maximum concentrations at the seeps would reach 813 and 17 μg/L for TCE and *cis*-1,2-DCE, respectively, for the baseline scenario. The estimated migration times for these levels of TCE and *cis*-1,2-DCE to the seep at Site 35 are 0 and 3 years Note that of the maximum predicted TCE concentration at the seeps is based on the current measured concentration at well 35-MW-8.

Groundwater concentrations at Site 35 seeps are predicted to reach 813 and 276 μg/L for TCE and *cis*-1,2-DCE, respectively, for the high-end sensitivity analysis range. At the low end of the sensitivity range, predicted concentrations of TCE and *cis*-1,2-DCE would reach 813 and 8 μg/L, respectively, at Site 35. (Again, TCE maximum concentrations at the seep are driven by measured existing conditions.)

Vinyl chloride, which was recently detected at low concentrations at 35-MW-7 as a result of the pilot remediation system in this area, is not predicted to migrate to the Site 35 seeps because it is anticipated that the expansion of the pilot remediation system in the Site 35 IRA proposed in this work plan will reduce vinyl chloride below MCLs before it leaves the treatment zone. Although vinyl chloride has only recently been detected, if degradation of vinyl chloride is not completed in the treatment zone, then predicted concentrations at the Site 35 surface discharge areas could potentially reach 26 μg/L (U.S. Air Force 2004). Based on the modeling presented in the Draft Final RI, the Site 35 plume will exceed cleanup goals for greater than 200 years.

4.2 CURRENT SITE RISKS

Human health and ecological risks summarized below are contained in the Draft Final RI Report, which is pending review and approval by the state regulators. Overall, these results indicate, with a high level of confidence, that no adverse non-carcinogenic health effects would be experienced by receptors at Sites 32 and 35 exposed to soils, sediments, surface water, and airborne constituents. Therefore, the site risks are evaluated in terms of groundwater exposure only.

4.2.1 Human Health Risk Evaluation

The results of the human health risk assessment indicate that risk estimates for industrial workers, construction workers, or visitors exposed to COPCs in soils, groundwater, sediments and surface water do not represent carcinogenic or non-carcinogenic health concerns, except for potential future use of groundwater in compliance with the beneficial use designation by the RWQCB Noncarcinogenic HIs for current and future workers and current and future visitors are far below the threshold HI of 1. Groundwater is not used currently for human potable purposes at Sites 32 and 35 However, to comply with the memorandum of agreement (MOA) between Vandenberg AFB, DTSC, and the RWQCB regarding groundwater evaluations, groundwater was considered to be a potential drinking water source at Sites 32 and 35 Carcinogenic risk probabilities and non-carcinogenic hazard indices (HIs) were calculated for assumed on-site industrial workers, construction workers, and off-site residents who were hypothetically assumed to use groundwater at Sites 32 and 35.

The risk estimates for the hypothetical use of groundwater at Site 32 are approximately 2 x 10^{-3} for industrial workers, 1 x 10^{-4} for construction workers, and 8 x 10^{-3} for residents. For the Site 35 plume, the risk estimates are approximately 5 x 10^{-5} for industrial workers, 4 x 10^{-6} for construction workers, and 1 x 10^{-3} for residents. All of these risk estimates exceed the point of departure of 1 x 10^{-6}. Further, the risk estimates for industrial workers drinking groundwater from the Site 32 plume and residents drinking groundwater from both plumes exceed the U.S. Environmental Protection Agency (EPA) target risk range of 10^{-6} to 10^{-4}.

For the Site 35 plume, the risk estimates are primarily caused by assumed exposures to TCE and, to a lesser extent to 1,1-DCE and 1,2-DCA Although predicted future concentrations at downgradient locations will decrease, assumed residential use of groundwater in downgradient locations results in risk estimates exceeding 1 x 10^{-6}. The predicted future conditions of TCE and 1,1-DCE result in risk estimates for residents hypothetically using groundwater from the Site 35 plume that exceed the U.S. EPA target risk range of 10^{-6} to 10^{-4}, while the risk estimate for residents hypothetically using groundwater from the Site 32 plume is within the target risk range, but in excess of the point of departure of 1 x 10^{-6}.

The non-carcinogenic HIs estimated for the hypothetical use of groundwater at Site 32 are approximately 12 for industrial workers, 25 for construction workers, 35 for adult residents, and 82 for child residents. For the Site 35 plume, the HIs are approximately 2 for industrial workers, 4 for construction workers, 22 for adult residents, and 82 for child residents. All of these HIs are all greater than the threshold HI of 1. Together, these results indicate that the potable use of groundwater at Sites 32 and 35 could result in adverse non-carcinogenic health effects for current and future conditions in the Site 32 plume but only for current conditions in the Site 35 plume. However, there are no plans to use the groundwater at Sites 32 and 35 for potable purposes in the future. Conceptual site models for current and future human receptors are shown on Figures 4.2-1 and 4.2-2.

4.2.2 Ecological Risk Evaluation

The ecological risk evaluation as performed in the RI has been submitted as Draft Final. No widespread or substantial ecological risks are likely to result from existing or future potential exposures to contamination at the site. Ecological risks were evaluated for two primary areas of concern at Sites 32 and 35: (1) the area inside the Site 32 fenceline and (2) the area outside of the Site 32 fenceline. The area outside of the Site 32 fenceline is addressed herein, as it includes the areas targeted for groundwater IRAs. Groundwater at Sites 32 and 35 is generally deeper than 5 feet below grade and is therefore not considered accessible to most plants and wildlife at the sites. Groundwater is accessible when it discharges at the surface forming the springs and cattle pond at the Site 32.

The ecological risk assessment indicates the potential for adverse impacts to cattle due to selenium in soils, and to aquatic invertebrates and amphibians due to chromium, selenium, and TCE in future surface water at the spring and cattle pond. At Site 32, the spring and cattle pond were considered to support aquatic receptors, including emergent plants, invertebrates, amphibians, and waterfowl in spite of the fact that this pond is heavily used by cattle as a drinking water source The federally threatened California red-legged frog has been observed at the cattle pond during past surveys (Christopher 1997). Current surface water concentrations of TCE and several metals in the spring and cattle pond exceeded screening toxicity reference values for amphibians. However, these exceedences are not likely associated with adverse effects because site-specific FETAX bioassays showed that the survival of frog embryos reared in Cattle Pond water was much greater than in the reference pond water (Turtle Pond). Current exposures of aquatic invertebrates in the spring and cattle pond resulted in hazard quotients (HQs) greater than 1 for aluminum, beryllium, cobalt, lead, selenium, silver, and vanadium, but these metals were not considered to pose a potential for adverse impacts because they were likely associated with the highly turbid surface water conditions in the pond and the use of unfiltered water results. A comparison of ambient water quality criteria to filtered surface water data will be provided in the final RI report for Site 32 Cluster. Future risks to aquatic biota at the freshwater spring and Cattle Pond from the Site 32 groundwater plume are unlikely However, TCE in the Site 32 plume could pose a potential for adverse effects to amphibians in the future, based on comparisons to ranges of toxicity values. Uncertainty concerning potential future risks to amphibians exists due to variability in limited toxicity data.

At Site 35, groundwater that may discharge at the seep near monitoring well 35-MW-8 was considered a potential drinking water source for terrestrial wildlife and cattle. It poses a negligible potential for current or future adverse ecological impacts A conceptual site model for ecological exposure pathways at Site 32 and Site 35 are shown on Figure 4.2-3.

4.3 REMOVAL ACTION CLEANUP GOALS

4.3.1 Remediation Goals

Interim remedial action goals for groundwater at Site 32 include (1) preventing potable uses of groundwater with chlorinated solvent concentrations that represent unacceptable levels of risks and exceed ARARs, and (2) remediating groundwater to conform to beneficial uses as designated by the RWQCB. The selected remediation goals for this IRA at Site 32 consist of the State of California drinking water standards, identified as the MCLs. For the contaminants of concern in site groundwater, these are: TCE, 5 µg/L; *cis*-1,2-DCE, 6 µg/L; *trans*-1,2-DCE, 10 µg/L; and vinyl chloride, 0.5 µg/L.

4.3.2 Applicable or Relevant and Appropriate Requirements

Tabulated summaries of potential applicable or relevant and appropriate requirements (ARARs) determined for TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, and vinyl chloride at Site 32 are presented in Appendix B. The Feasibility Study for Sites 32 and 35 will evaluate the technical and economical feasibility of alternatives to achieve background (i.e., nondetectable) levels of VOCs in groundwater.

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5.0 EVALUATION OF REMEDIAL ALTERNATIVES

The following removal action alternatives for the chlorinated VOC-contaminated groundwater at Site 32 have been identified and screened:

(1) No Action / MNA;

(2) Permeable Reactive Barrier (PRB);

  (a) Implemented with Bark Mulch;

  (b) Implemented with Iron Filings; and

(3) Phytoremediation Barrier.

The alternatives proposed in this section are based on a timeline of 30 months; 9 months for approval of the RAW, 6 months for construction followed by 12 months of monitoring, followed by 3 months of follow-up reporting. Although cleanup of the Site 32 TCE plume to remediation goals using one of the above-mentioned alternatives will likely be necessary for a period of time beyond 30 months (the barrier technologies are considered to rely on passive groundwater velocity) it is assumed that the monitoring and reporting of the selected alternatives will be completed under the Remedial Action-Construction (RA-C) phase, after completion of the Remedial Investigation/Feasibility Study (RI/FS).

5.1 EVALUATION CRITERIA FOR PROPOSED REMEDIAL ALTERNATIVES

California's Health and Safety Code Section 25356.1(d) requires that Remedial Action Plans be based on the National Contingency Plan (NCP). The NCP identifies nine criteria, or standards, that can be used to evaluate remedial alternatives. Because the nine criteria provide a thorough, standardized method to compare alternatives, they are used for the Site 32 IRA. The nine criteria, as modified by the State of California, are listed below

1. **Overall Protection of Human Health and the Environment**
   Addresses whether a remedy provides adequate protection of human health and the environment and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. **Compliance with State and Federal Requirements**
   Addresses whether a remedy will meet all appropriate federal, state, and local environmental laws and regulations. This evaluation is a step to identify potential applicable or relevant and appropriate requirements (ARARs). **Applicable requirements** are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal, state, or local laws that specifically address the situation at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. **Relevant and appropriate requirements** are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal, state, or local

laws that, while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action, and are well suited to the conditions of the site (U.S. EPA 1988). ARAR determination is an iterative process that requires the Air Force, as the lead federal agency, and the state to work together to identify and consider ARARs at critical points of the removal process.

Tabulated summaries of potential ARARs for Sites 32 and 35, which originated from the *Management Action Plan* (U.S. Air Force 1999b), are presented in Appendix B.

3. **Long-Term Effectiveness and Permanence**
Refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met.

4. **Reduction of Toxicity, Mobility, and Volume Through Treatment**
Refers to the ability of a remedy to reduce the toxicity, mobility, and volume of the hazardous substances or constituents present at the site.

5. **Cost: 30-Year Present Worth**
Evaluates the estimated 30-year, present-worth costs of each remedy including capital, operation, and maintenance costs.

6. **Short-Term Effectiveness**
Addresses the period of time needed to complete the remedy, and any adverse impact on human health and the environment that may be posed during the construction and implementation period, until the cleanup standards are achieved

7. **Implementability**
Refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to carry out a particular option

8. **Regulatory Agency Acceptance**
Indicates whether, based on its review of the information, the applicable regulatory agencies would agree with the preferred alternative.

9. **Community Acceptance**
Indicates whether the remedy addresses community concerns, and whether the community has a preference for a remedy.

For an alternative to be eligible for selection, it must meet the first two criteria described above, called "threshold criteria." Criteria 3 through 7 are the "primary balancing criteria" and criteria 8 and 9 are "modifying criteria" (DTSC 1995). The NCP (40 Code of Federal Regulations [CFR] 300.403[e]) provides further discussion on the use of these criteria.

5.2 EVALUATION OF ALTERNATIVES

This section evaluates remedial alternatives for chlorinated VOC-contaminated groundwater at Site 32. Each alternative will be based upon the NCP criteria.

5.2.1 Alternative 1: No Action/Monitored Natural Attenuation

Alternative 1 is a baseline scenario to which other management alternatives can be compared Under Alternative 1, no removal action or institutional controls would be administered, however monitoring and reporting of groundwater would continue under the BGMP.

For Alternative 1, numerous physical and chemical groundwater parameters would be periodically monitored in groundwater to assess the potential for intrinsic biodegradation of chlorinated solvents. Anaerobic conditions (low dissolved oxygen and negative oxidation reduction potential) are favorable for the initial degradation of TCE and its daughter products. Where MNA potential is high and where an imminent risk to human health and the environment does not exist, MNA may be the remediation method of choice for groundwater contaminated with petroleum hydrocarbons or chlorinated ethenes. MNA is accepted by the U.S. EPA and all states when supported by field data. Implementation is usually straightforward and operation and maintenance (O&M) involves well maintenance, a monitoring schedule, and project reporting. If implemented, MNA could be used as the sole remedy, or as part of a more complex remediation strategy.

Fate and transport modeling demonstrates the effects of the natural attenuation processes on the future TCE groundwater plume at Site 32. During the MNA alternative, concentrations at the Site 32 seep reach 12.5 µg/L for TCE and 1.2 µg/L for *cis*-1,2-DCE by approximately 2010 to 2014 (6 to 10 years from present). The seep TCE concentrations exceed the TCE MCL of 5 ug/L for a 20-year period beginning in 2007 and ending in 2027 Concentrations of *cis*-1,2-DCE remain below the MCL of 6 µg/L during the entire prediction period The fate and transport modeling indicates that natural attenuation processes are not adequate in decreasing TCE concentrations at the perennial spring below the remediation goals (i.e., MCLs) within a reasonable timeframe. MNA was developed as a method to provide remediation of groundwater at significantly reduced costs while still being protective of human health and the environment. MNA is accepted by the U.S. EPA and all states when supported by field data. MNA has as its basis the degradation of groundwater contaminants by naturally occurring microorganisms. Implementation is usually straightforward and operation/ maintenance is simple. This alternative prohibits the ingestion of contaminated groundwater, until final cleanup goals for such use are met.

5.2.1.1 Overall Protection of Human Health and the Environment

State Water Resources Control Board (SWRCB) Resolution 68-16 establishes the policy that high-quality waters of the State shall be maintained to the maximum extent possible "consistent with the maximum benefit to the people of the State" (SWRCB, 1994). This requirement has been interpreted for this RAW to apply to any groundwater that may have future beneficial use for the people of the State. Alternative 1, based on computer modeling, is demonstrated to result in MCL exceedances at the groundwater seep location 32J-SW-3, and therefore does not provide for improvement of groundwater conditions and protection of human health and the environment. Therefore, the MNA alternative does not meet the first of the two threshold criteria.

5.2.1.2 Compliance with State and Federal Requirements

Historical detections of VOCs at Site 32 do not indicate that TCE is readily biodegrading into its daughter products *cis*-1,2-DCE, *trans*-1,2-DCE, and vinyl chloride. If this were the case, the data would indicate increasing detections of these specific contaminants. Since there are only slight detections of contaminants caused by the breakdown of TCE, namely *cis*-1,2-DCE present in analytical data, the MNA remedial alternative is primarily based upon the dilution and dispersion of the plume as it migrates southwest towards the spring. The groundwater modeling summarized in Section 4.3 demonstrated that the migration and volatilization of TCE in the plume, once having passed through the spring, would not be adequate in decreasing the concentration of TCE below the California MCL of 5 µg/L. Institutional controls would be an integral part of this alternative, if selected. Five-Year Review Reports would be completed during the operation of this alternative in order to evaluate the nature and extent of contamination at Site 32 and ensure that human and ecological exposure to such contamination would not occur. However, Alternative 1 would not reduce contamination levels below MCLs; therefore this alternative does not meet the second of the two threshold criteria and will not be evaluated further.

5.2.2 Alternative 2: Permeable Reactive Barrier Technology Using either Iron Filings or Bark Mulch

In a continuous PRB, treatment material is distributed across the path of the contaminated groundwater. In the case of granular iron, the iron has a hydraulic conductivity greater than many aquifers and thus should not significantly alter the natural groundwater flow path or velocity. A permeable zone of iron granules, other minerals, or organic materials can be designed to create a reactive treatment barrier oriented to intercept and remediate a contaminant plume This barrier allows the passage of water while degrading contaminants. A PRB could also be installed in which bark mulch is placed (potentially with other inert media) in the subsurface to provide a carbon source (electron donor approach) to support biodegradation via reductive dechlorination pathways. Pilot-scale testing has been completed of a permeable reactive biowall at Offutt AFB near Omaha, Nebraska. Demonstration findings suggest that this technology is appropriate at sites with shallow (less than 8 feet) groundwater and biowalls extending less than 30 feet below ground surface (bgs). Performance data from the Offutt AFB pilot study indicated that the biowall is a low-maintenance, cost effective, in-situ treatment wall technology. Prior studies by others indicate that a mulch-based biowall will last approximately 10 years; with iron filing walls lasting a slightly shorter duration. The precise location of the PRB will be dependant upon the supplemental groundwater investigation data obtained via Hydropunch technology to further characterize the nature and extent of the groundwater contamination. Each hypothetical PRB is assumed to be constructed using a continuous trenching device with dimensions of 1,350 feet in length, 20 feet in depth, and 3 feet in the width. In addition to the PRB, a total of 7 monitoring wells will be installed upgradient (2 wells), within (3 wells), and downgradient (2 wells) of the PRB to monitor the degradation process. This alternative prohibits the ingestion of contaminated groundwater, until final cleanup goals for such use are met.

5.2.2.1 Overall Protection of Human Health and the Environment

Performing the installation of the PRB would be expected to eliminate existing unacceptable risks due to potential current and future human receptors as stated by SWRCB Resolution 68-16. With regard to the environment, equipment operation associated with remedial activities would cause a short-term disturbance of vegetation and animals at Site 32 (e.g., with the installation of permeable reactive barrier, groundwater monitoring wells, and regular O&M activities). Short-term impacts will be mitigated with access control measures during the field activities.

5.2.2.2 Compliance with State and Federal Requirements

Tabulation of potential ARARs identified for Site 32C are provided in Appendix B. If applied successfully, Alternative 3 would comply with the federal, state, and local requirements presented in these tables. In addition, institutional controls would be an integral part of this alternative, if selected. Five-Year Review Reports would be completed during the operation of this alternative in order to evaluate the nature and extent of contamination at Site 32 as the operation of the PRB progresses and ensure that human and ecological exposure to such contamination would not occur.

5.2.2.3 Long-Term Effectiveness and Permanence

The final, long-term remedy for the source area at Site 32 will be addressed during the RA-C after completion of the RI/FS. This remedy will most likely incorporate the existing PRB coupled with long-term monitoring and reporting to carry the process through to the RA-C and O&M phases. The PRB alternatives will likely be effective over the long-term in reducing VOC concentrations downgradient of the source areas, thus protecting the beneficial uses of the aquifer. The reported "lifetime" of iron and bark mulch walls range up to 10 or more years.

5.2.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This alternative involves the manipulation of the subsurface groundwater environment to facilitate contaminant degradation. Contamination moving through the groundwater will be degraded based on the amendments added. Contaminant levels will be reduced and will be prevented from moving downgradient; therefore, the toxicity, mobility, and volume of contamination are expected to be reduced to achieve acceptable risk levels at Site 32.

5.2.2.5 Cost

The estimated cost associated with the PRB constructed with iron filings (2 VI) and bark mulch are approximately $2,637,548.40 and $873,955.20, respectively. These costs assume a uniform total project duration including operation and maintenance costs for 30 months. Details of costing for the PRB are outlined in Appendix D, Tables D-1 and D-2.

5.2.2.6 Short-Term Effectiveness

After the PRB is constructed, it will require several months to a few years for the groundwater environment to show significant changes. During installation of Alternative 2, short-term risks associated with the use of heavy equipment will be created, including movement of drill rigs and excavators around the site. A Health and Safety Plan is included as Appendix C so that workers can address removal action hazards, but this administrative tool will not eliminate all site hazards. Ecological resources would be affected by traffic to and from the site, and by drilling and installation equipment. Implementing access control measures during the field activities will minimize these short-term impacts. The habitat in the proposed IRA area of Site 32 is annual grassland which has historically been subjected to overgrazing. It currently features ruderal species and provides marginal habitat. The proposed IRA area is confined to a space of approximately 0.8 acres or less, which is small area relative to the site cluster. No federally threatened species are known to have been observed in the proposed IRA area. Therefore, short-term impacts to this area would be marginal as well, confined to a relatively small area. The permeable reactive barrier (trench) will be a linear feature confined to a small area, and will result in short-term subsurface disturbance to a small area. Mitigation measures would include using existing roads for ingress/egress and for temporary staging and stockpiling of equipment and any residual soil piles during the work.

5.2.2.7 Implementability

Implementing a PRB would be administratively and technically feasible. Materials, equipment, and services necessary for this alternative are readily available. Due to the lack of the demonstrated success of bark mulch walls at Vandenberg AFB, an initial bench scale study would be carried out using at least three different types of bark and sand to develop an understanding of the optimal organic substrate mix and to estimate residence times necessary to completely destroy TCE into innocuous end products. The results of the pilot study would be used to refine the PRB wall construction design. For the bark mulch option, it is assumed that a 3-foot-thick wall will be constructed at each location using a mixture of 50 percent sand and 50 percent black bark mulch procured from a local vendor. For the iron filing option, it is assumed that up to 2,400 tons of iron filings will comprise the reactive portion of the PRB. Implementing this alternative would involve excavation subcontractors, drilling and well installation subcontractors, bark mulch or iron filing subcontractors, and laboratory subcontractors.

5.2.2.8 Regulatory Agency Acceptance

Although regulatory agency acceptance of this alternative is anticipated, Tetra Tech and the Air Force would work closely with DTSC and the RWQCB, as needed, during the approval process. In addition, all pertinent ARARs are listed in Appendix B.

5.2.2.9 Community Acceptance

Community acceptance of this alternative would be expected because treatment of the contaminated groundwater would protect the beneficial use of the aquifer. The groundwater would be treated in place. Minimal but manageable impacts to the environment are expected during installation and operation of this action. Minimal impacts to local traffic would result from this alternative. Impacts to local traffic would include subcontractors entering and leaving Vandenberg AFB during field activities.

5.2.3 Alternative 3: Phytoremediation Barrier

At Site 32, a phytoremediation barrier would be installed. Phytoremediation is a technology that uses plants and their associated rhizospheric microorganisms to remove, degrade, or contain chemical contaminants located in the soil, sediments, groundwater, surface water, and even the atmosphere. Researchers have found that plants can be used to treat most classes of contaminants, including petroleum hydrocarbons, chlorinated solvents, pesticides, metals, radionuclides, explosives, and excess nutrients. Plant species are selected for phytoremediation based on their potential to evapotranspirate groundwater, the degradative enzymes they produce, their growth rates and yields, the depth of their root zone, and their ability to bioaccumulate contaminants.

Despite the diversity of phytoremediation technologies, its application is limited by a number of factors. Phytoremediation can only work at sites that are well suited for plant growth. This means that the concentration of pollutants cannot be toxic to the plants, and the pollution cannot be so deep in the soils or groundwater that plant roots cannot reach it. As a result, phytoremediation may be a good strategy for sites conducive to plant growth with shallow contamination, it may be a good secondary or tertiary phase in a treatment train for highly polluted sites, or it may not be a viable option for a site. However, the conditions of Site 32 (i.e., shallow groundwater and relatively low concentration of contaminants) provide a suitable environment and an opportunity to use phytoremediation as a viable means to address chlorinated solvents present in the groundwater. In addition, willow trees will be the selected plant due to their native presence at Vandenberg AFB. Proposed spacing is at 15-foot intervals, comprising three parallel rows.

Before the trees are planted, analytical data will be obtained via the use of Hydropunching technology to further characterize the nature and extent of the groundwater contamination. Based upon these data, the placement of the willow trees will be finalized. After the trees are planted, an 8-foot high fence will be constructed to reduce the threat of animal disturbance to the trees. In addition, up to 10 groundwater monitoring wells will be installed in the vicinity of the phytobarrier to monitor groundwater levels and the degradation process. It is important to note that a certain percentage of willow trees will die due to adverse conditions, and this should be taken into account when purchasing the trees. To ensure a higher survival rate, it is recommended that the trees be planted first in 5-gallon containers, and once a root system has developed, replanted on site. This alternative prohibits the ingestion of contaminated groundwater, until final cleanup goals for such use are met

5.2.3.1 Overall Protection of Human Health and the Environment

Performing phytoremediation would likely eliminate existing unacceptable risks due to potential current and future human receptors as stated by SWRCB Resolution 68-16. With regard to the environment, equipment operation associated with remedial activities would cause a short-term disturbance of vegetation and animals at Site 32 (e.g., with the plantation of trees and its associated fence, installation of groundwater monitoring wells, and regular O&M activities) Short-term impacts will be mitigated with access control measures during the field activities

5.2.3.2 Compliance with State and Federal Requirements

Tabulation of potential ARARs identified for Site 32C are provided in Appendix B. If applied successfully, Alternative 3 would comply with the federal, state, and local requirements presented in these tables. In addition, institutional controls would be an integral part of this alternative, if selected. Five-Year Review Reports would be completed during the operation of this alternative in order to evaluate the nature and extent of contamination at Site 32 as the operation of the phytoremediation barrier progresses and ensure that human and ecological exposure to such contamination would not occur.

5.2.3.3 Long-Term Effectiveness and Permanence

The final, long-term remedy for the source area at Site 32 will be addressed during the RA-C after completion of the RI/FS. This remedy will most likely incorporate the existing phytoremediation barrier coupled with long-term monitoring and reporting to carry the process through to the RA-C and O&M phases. The phytoremediation alternative will likely be effective over the long-term in reducing VOC concentrations in the groundwater downgradient of the source areas (i.e., at the spring) thus protecting the beneficial uses of the aquifer.

5.2.3.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This alternative involves the manipulation of the surface (trees and associated fences) and subsurface environment to facilitate contaminant degradation. Contaminated groundwater will be uptaken by the willow phytobarrier at Site 32. Contaminant levels will be reduced and will be prevented from moving downgradient; therefore, the toxicity, mobility, and volume of contamination will be reduced to achieve acceptable risk levels at Site 32.

5.2.3.5 Cost

The estimated cost associated with phytoremediation is approximately $541,242.00. A detailed breakdown of these costs is provided in Appendix D, Table D-3. This cost assumes a total project duration for activities performed under the IRA including O&M costs for 30 months.

5.2.3.6 Short-Term Effectiveness

After amending the surface and subsurface environments at Site 32, one to two years may be required for tree roots to extend into the groundwater The impact of the phytoremediation project will be increased evapotranspiration within the planted area at evapotranspiration rates up to 5 feet per year. During installation of Alternative 3, short-term risks associated with the use of heavy equipment will be created, including movement of drill rigs around the site. A Health and Safety Plan is included as Appendix C that workers can address removal action hazards, but this administrative tool will not eliminate all site hazards. Ecological resources would be affected by traffic to and from the site, and by drilling and installation equipment. Implementing access control measures during the field activities will minimize these short-term impacts. The habitat in the proposed IRA area of Site 32 is annual grassland which has historically been subjected to overgrazing. It currently features ruderal species and provides marginal habitat. The proposed IRA area is confined to a space of approximately 0.8 acres or less, which is small area relative to the site cluster. No federally threatened species are known to have been observed in the proposed IRA area. Therefore, short-term impacts to this area would be marginal as well, confined to a relatively small area. The phytoremediation alternative includes construction of a perimeter fence to protect trees from grazing cattle. The fence construction will permit small animals to enter the planted area, while restricting entrance from cattle and deer. Mitigation measures would include using existing roads for ingress/egress and for temporary staging and stockpiling of equipment and any residual soil piles generated during the work. Depressions will be constructed around the bases of planted trees and watering will be scheduled to result in no surface water runoff. Periodic weed abatement would be conducted to foster tree growth.

5.2.3.7 Implementability

Implementing phytoremediation would be administratively and technically feasible. Materials, equipment, and services necessary for this alternative are readily available. Willow trees will be grown in suitable pots and planted in the fall season to ensure a higher rate of survivability. It is possible to plant whips of the willow trees; however, the trees will have a lower rate of survivability. Implementing this alternative would involve nursery subcontractors, drilling and well installation subcontractors, and laboratory subcontractors.

5.2.3.8 Regulatory Agency Acceptance

Although regulatory agency acceptance of this alternative is anticipated, Tetra Tech and the Air Force would work closely with DTSC and the RWQCB, as needed, during the approval process. In addition, all pertinent ARARs are listed in Appendix B.

5.2.3.9 Community Acceptance

Community acceptance of this alternative would be expected because treatment of the contaminated groundwater would protect the beneficial use of the aquifer. The groundwater would be treated in place. Minimal but manageable impacts to the environment are expected during installation and operation of this action. Minimal impacts to local traffic would result from this alternative. Impacts to local traffic would include subcontractors entering and leaving Vandenberg AFB during field activities. In addition, use of phytoremediation provides aesthetic enhancement, and an additional wildlife habitat.

5.3 COMPARISON OF SELECTED ALTERNATIVES

A screening table (Table 5.3-1) was prepared to compare the selected alternatives in terms of short- and long-term effectiveness, implementability, and cost. These categories were assigned a number from 0 (the least desirable rank) to 3 (the most desirable rank). These numbers were added and a total rank was assigned to each alternative. In addition, Appendix D outlines a detailed cost analysis of the remedial alternatives that are feasible (Alternatives 2A, 2B, and 3). Based on the comparison of Effectiveness, Implementability, and Cost, Alternative 3, phytoremediation, scores the highest and therefore is the best technology for remediation of VOCs at Site 32.

Table 5.3-1
Relative Ranking of Remedial Alternatives

Alternative	Short- and Long-Term Effectiveness	Implementability	Cost	Total Rank
2a Permeable Reactive Barrier Using Iron Filings	3	2	1	6
2b. Permeable Reactive Barrier Using Bark Mulch	3	2	2	7
3. Phytoremediation	3	3	3	9

Notes: The number 0 indicates the least desirable rank; 3 denotes the highest.

At the appropriate sites, phytoremediation programs are generally easily implemented, offer aesthetic value, and use very low cost technology. Suitable trees are available at local nurseries, and site conditions are well suited for a phytoremediation program (shallow groundwater, low groundwater velocity, low VOC concentrations, and available timeframe for remedy to achieve desired results). Technical implementability is rated high for this alternative.

Costs for Alternative 3, the phytoremediation barrier, include procuring 360 willow trees in 5-gallon containers and planting them in three rows perpendicular to the direction of groundwater flow in the area of the downgradient Site 32 plume, near well 32-MW-3. An initial Hydropunch program with 10 grab sample locations is included to finalize placement of the installation. An array of 10 new monitoring wells would be installed upgradient, within, and downgradient of the phytoremediation area, with a 12-month quarterly groundwater monitoring program for VOCs and general mineral parameters. It is anticipated that willow roots will tap directly within the 2.5 to 5 foot deep water table within 1 to 2 years after planting, causing measurable declines in water level elevation and VOC concentrations in groundwater. Procurement of a meteorological station and use of water level sensors in dedicated wells with data logging is included, as is preparation of four quarterly monitoring reports documenting the data and findings associated with the program. Based on these provisions, the total estimated cost is $541,242.00.

5.4 SUMMARY OF PREFERRED REMEDIAL ALTERNATIVE

The preferred remedial alternative, based on long-term effectiveness, implementability, and cost, is Alternative 3, phytoremediation. A phytoremediation project would be constructed perpendicular to the direction of groundwater flow, at a location downgradient (west) of existing well 32-MW-3. Groundwater at this general location is shallow (about 2.5 to 5 feet below grade), moves relatively slowly (i.e., estimated velocity of 0.5 foot per day, existing TCE concentrations are quite low (8.8 µg/L in winter 2004), and geochemistry data suggest conditions conducive to vegetation growth. Initially, a supplemental groundwater investigation, consisting of 10 Hydropunch grab samples, would be completed and sample analyses used to verify the precise location of the barrier.

The proposed phytoremediation tree would be the Arroyo willow, which exhibits rapid growth, high evapotranspiration (ET), is indigenous to Vandenberg AFB, and prefers shallow groundwater conditions. Based on some guidance documents, a full-grown willow can use up to 200 gallons of groundwater per day or more (Interstate Technology and Regulatory Cooperation Work Group 2001). The existing computer model indicated a need to pump approximately 10 gallons per day to contain the Site 32 plume.

The design assumed a maximum pumping rate of 20 gallons per day for a full grown tree (10 times lower than guidance), and provides for 360 willows, planted in three rows with 120 trees per row, planted at 15 feet spacing intervals. To encourage rapid growth, 5-gallon willows would be procured from a local nursery. Four foot deep holes will be drilled, and the willows planted three feet deep with approximately 1 to 2 feet of willow tip protruding from the earth. This approach should ensure that the willow roots grow within the water table within a 1 to 2 year timeframe. Watering would be conducted during the initial summer months only at rates less than the calculated ET. A weather station with solar batteries would provide the basis for the ET calculations. An 8-foot fence would surround the trees for protection from deer and other animals. A local nursery will provide quarterly maintenance, weed abatement, and watering.

A total of up to 10 new wells would be constructed upgradient, within, and downgradient of the barrier to assess its effectiveness at removing TCE and daughter products from groundwater. Quarterly monitoring would be conducted for 1 year with analysis of VOCs and general mineral parameters. Water level data logging would be conducted for 6 months during the growing season to document fluctuations in water levels in the wells constructed within the planted area. Quarterly monitoring reports will be prepared following each sampling event, and a comprehensive final report will be prepared at the completion of the program. Performance standards will provide key insight as to the overall effectiveness of the phytoremediation barrier to uptake the VOC-contaminated groundwater. Effectiveness of the project will be determined by the presence of a localized depression in the water table surface in the immediate vicinity of the barrier, documentation of reductions in flow of the spring downgradient, and declines in COC concentrations downgradient from the barrier and in the spring over time.

6.0 REMOVAL ACTION IMPLEMENTATION

This section discusses the implementation of the phytoremediation alternative selected for the remediation of VOC impacted groundwater at Site 32 In addition to the removal action at Site 32, a Treatability Study will be concurrently conducted at Site 35 to assess the effectiveness of a proposed technology. Therefore, this RAW also contains the detailed work plan of the Site 35 Treatability Study. The implementation of the Site 32 removal action and Site 35 Treatability Study consists of four phases; with accompanying scopes summarized in Table 6 0-1, and detailed in the next section.

6.1 SCOPE OF WORK

6.1.1 Sites 32 and 35 Supplemental Groundwater Investigation

Two separate plumes of chlorinated solvents have been detected in continuous groundwater zones at the downgradient margins of Sites 32 and 35. Prior to implementing the Site 32 IRA and Site 35 Treatability Study, a supplemental groundwater investigation will be conducted in order to fill data gaps and characterize the nature and extent of groundwater contamination at Site 32 and Site 35. Data from this program will aid in designing the Site 32 IRA and Site 35 Treatability Study.

At Site 32, up to ten Hydropunch groundwater grab samples will be collected to further delineate the extent of the Site 32 VOC plume and to refine the locations of the phytoremediation barrier Information on the presence of and depth to groundwater along the downgradient extent of the plume before the surface water exposure point location at the Site 32 spring will be used to determine the optimum locations for planting willow trees. The ideal depth to groundwater for the willow tree planting is between 2 5 and 4 feet bgs The Hydropunch samples collected will be from ten locations within and immediately around the TCE plume delineated by the MCL of 5 µg/L as outlined in Figure 6-1 1. These locations have been chosen based on various TCE concentrations detected at previous sampling locations at the site.

At Site 35, up to 25 Hydropunch grab samples will be collected in various portions of the plume to characterize the nature of groundwater occurrence and flow at the downgradient portion of the plume and to further delineate its vertical and lateral extent The Hydropunch program will be used to assess whether groundwater is completely discharged at the Site 35 seep area or a portion of it flows south toward the spring. To accomplish this objective, up to 6 Hydropunch locations will be completed as temporary piezometers. The Hydropunch results and existing site monitoring wells will be used to refine the location of the Treatability Study.

At Site 35, the groundwater investigation will include additional fate and transport modeling that will also be used to characterize the groundwater flow and transport and to refine the location of the Treatability Study.

6.1.2 Site 32 Phytoremediation Barrier Interim Removal Action

A low level plume of chlorinated VOCs has been detected in a continuous groundwater zone at Site 32. The IRA at the site is designed to control the migration of the groundwater contamination plume and minimize impacts to sensitive habitats at the site. The IRA shall consist of a phytoremediation barrier at the downgradient margin of the Site 32 plume. Work activities will consist of planting of trees for the purpose of naturally extracting chlorinated VOCs in groundwater through evapotranspiration.

A phytoremediation barrier will be constructed at Site 32 perpendicular to the direction of groundwater flow, at a location downgradient of existing well 32-MW-3 The phytoremediation barrier will consist of up to 360 willow trees, planted in three rows and spaced at 15-foot intervals within an area estimated to be up to approximately 1,350 feet long and 50 feet wide. It may be necessary to plant willows in a direction trending east-west immediately above the spring. The final location of the phytoremediation barrier will be based upon the results of the Hydropunch investigation and from data from existing site monitoring wells. An 8-foot fence will be constructed around the phytoremediation site to protect the trees from deer and other animals that may interfere with tree development. A weather station with solar batteries will be installed to provide data for evapotranspiration rate calculations. Watering would be conducted during the first year only at a rate less than the calculated ET rate.

Up to ten additional groundwater monitoring wells will be installed at Site 32 upgradient, within, and downgradient of the proposed phytoremediation barrier to monitor the plume and the effectiveness of the phytoremediation barrier. The final locations of these wells will be selected based upon the analytical results of the 10 Hydropunch samples and the existing site monitoring wells.

6.1.3 Site 35 Treatability Study

A plume of chlorinated VOCs has been detected in a continuous groundwater zone at Site 35 A technology demonstration program utilizing injection of molasses at the site has successfully demonstrated the use of an IRZ to permit biodegradation of chlorinated solvents within a small portion of the plume near well 35-MW-7. The demonstration project is qualified as having demonstrated that anaerobic conditions can be successfully induced in the aquifer at Site 35, with evidence of at least partial reductive dechlorination in several monitoring wells. For example, monitoring well 35-MW-20, located immediately downgradient of the injection zone, showed a decrease in TCE of 280 µg/L or 2.13 µM/L over the course of the ARCADIS project. The compound *cis*-1,2-DCE increased 85.5 µg/L or 0.88 µM/L during the same time period. This demonstrates that approximately 40 percent of the *cis*-1,2-DCE is directly attributed to the breakdown of TCE aided by the biodegradation. Tetra Tech will conduct a Treatability Study at the site to assess the efficacy of injecting emulsified soybean oil to promote degradation of TCE and degradation daughter products present in groundwater at Site 35. The Treatability Study will consist of an injection barrier to create an IRZ approximately 200 feet upgradient of well 35-MW-8 Work activities will consist of bench scale testing to assist in the final design of the in-situ Treatability Study and installation of a soybean oil injection barrier for in-situ treatment of chlorinated VOCs in groundwater.

The injection barrier will be installed across the Site 35 groundwater plume. The injection barrier will consist of a 200-foot array of up to 20 injection wells spaced at 10-foot intervals, installed perpendicular to the direction of groundwater flow Soybean oil will be injected using a substrate mass that is calculated to be sufficient to completely dechlorinate existing concentrations of TCE and its degradation daughter products in the aquifer.

Up to 10 additional monitoring wells, each fitted with a Micropurge pump, will be installed at Site 35 to monitor the injection barrier.

6.1.4 Sites 32 and 35 Monitoring and Reporting

To monitor the effect of the phytoremediation barrier on the Site 32 plume, groundwater samples from the new Site 32 monitoring wells will be collected and analyzed quarterly for 1 year after installation. Water levels will be monitored for 6 months to measure the effect of ET during the growing season.

Groundwater samples from the new Site 35 monitoring wells will be analyzed prior to injection of soybean oil (i.e., baseline) and quarterly for 1 year following injection.

Tetra Tech will prepare and submit four quarterly technical memoranda containing all data collected during the Treatability Study and IRA. The reports will include a description of field activities, photographic documentation, analytical data, and recommendations. The first quarterly report will include both the baseline monitoring at Sites 32 and 35 and results from the first quarterly sampling event, a summary of the benchscale testing, and a summary of the Site 32 IRA and Site 35 Treatability Study implementation. Tetra Tech will report the results of the sampling, water level measurement, and interpretation. The final quarterly report will be a comprehensive report including a summary of all activities conducted for the entire Treatability Study and IRA, and any recommendations. The monitoring and reporting for the IRA will continue through the BGMP on a semiannual basis. The progress of the phytoremediation barrier will be documented in the BGMP reports. This time period will allow a longer time range to evaluate the effectiveness of the barrier.

6.2 SITES 32 AND 35 GROUNDWATER INVESTIGATION

This section presents in detail the Hydropunch investigation design and sampling procedures, groundwater modeling, and the groundwater investigation reporting

6.2.1 Design of Hydropunch Investigation

The Hydropunch investigation will assist in providing supporting data to aid in delineating the nature and extent of groundwater and the VOC-contaminated plumes that exist at Sites 32 and 35. Sampling rationale is shown in Table 6.2-1.

The plume at Site 32 is currently defined by three monitoring wells (32-MW-2, 32-MW-3, and 32-MW-7) that consistently show concentrations of TCE above the California MCL of 5 μg/L and two surface water sampling locations (32J-SW-1 and 32-J-SW-3) that are either non-detect or show concentrations of 1 to 3 μg/L. The extent of the plume beyond these wells and surface water locations is relatively uncertain. Although analysis has been performed on groundwater sampled from wells and seeps, as well as Hydropunch samples in the vicinity of the VOC plume, the boundary is not clearly defined. The Hydropunch samples will aid in defining the plume boundary. Hydropunch samples are proposed on the north and south boundaries of the plume to further clarify the width of the plume. Figure 6.1-1 illustrates the Site 32 and Site 35 proposed Hydropunch sampling locations (H-W through H-Y). These Hydropunch samples will be collected between approximately 22 to 27 feet bgs considering that TCE in groundwater in this area of Site 32 is in the dissolved phase (Table 6.2-1). Based on data obtained from boring logs of monitoring wells and recent water level measurements recorded during July 2004 in this area, the upper to middle zone of groundwater occurs at this range of depth.

As stated in Section 2.2.4, monitoring well 35-MW-8 exhibits artesian characteristics and as a result, suggests a bedrock elevation high immediately west of this location, or the effects of a confining clay layer above the screened interval. It is possible, due to the general lack of groundwater flow west of well 35-MW-8 (i.e., wells 35-MW-9 and 35-MW-10 are typically dry), that there may be a southerly direction of flow dowgradient of well 35-MW-8. To assess this possibility, Hydropunch sampling locations (H-L through H-Q) are proposed in the area between the spring and monitoring well 35-MW-8. Up to six of these Hydropunch locations may be completed as piezometers in order to allow for monitoring of groundwater elevation. The ability to monitor the water levels in this particular area over time will clarify if, and how much of, a southerly component exists in groundwater flow direction. Hydropunch samples will be collected from the interval approximately 15 feet bgs to bedrock (Table 6.2 1).

When conducting Hydrosparge analyses at Site 35 in preparation for the IRZ demonstration project, ARCADIS discovered an extension of the VOC plume north of monitoring well 35-MW-1. ARCADIS Hydrosparge samples 35-H-1B and 35-H-1C indicated the presence of TCE at a depth of 41.6 feet bgs at concentrations of 1,000 and 5,000, respectively. Historical data from monitoring well 35-MW-1, immediately south of these Hydrosparge locations, do not support the ARCADIS data. However, upon further investigation, the screened interval of monitoring well 35-MW-1 (18 to 38 feet bgs) is approximately 8 feet above the bedrock contact. Therefore, the sampling data acquired from 35-MW-1 may not be representative of the VOC conditions in this area, as TCE is a DNAPL, and would be found at the bottom of the saturated zone, just above bedrock. To further clarify whether TCE is present above the California MCL of 5 µg/L, Hydropunch sampling (H-A through H-D) is proposed in the vicinity of 35-MW-1 and in the vicinity of the former drainage channels associated with the source of the VOC contamination. These Hydropunch samples will be collected from between approximately 35 feet bgs to bedrock as TCE is suspected to be present at the bedrock/aquifer interface as DNAPL (Table 6.2.1).

Hydropunch samples H-E through H-K and H-R through H-V are proposed to further delineate the nature and extent of the groundwater TCE plume for Sites 35 and 32, respectively. Hydropunch samples H-E through H-K will be collected from between approximately 18 to 25 feet bgs as TCE is likely to be present in this area. Hydropunch samples H-R through H-V will be collected from between approximately 14 feet bgs to bedrock.

Hydropunch samples H-Z and H-AA will be collected from the drainage channel areas of Channel 32B and Channel 32C, respectively (Figure 6.1.1) to determine the presence of TCE as a DNAPL in this area. For this reason, these Hydropunch samples will be collected from between approximately 42 feet bgs to bedrock (Table 6.2.1).

A total of 27 Hydropunch locations are proposed for Site 32 Cluster to further delineate the nature and extent of the VOC plumes. The locations of these Hydropunch samples may vary slightly as data are obtained. These data may introduce the potential for samples to be collected in different locations, or not at all. An additional 8 Hydropunch step-out sample locations (not shown in Figure 6.1-1) may be completed based upon analytical data received from the initial 27 locations.

6.2.2 Hydropunch Sampling

The Hydropunch is a stainless steel and Teflon sampling tool that is capable of collecting a representative groundwater grab sample without requiring the installation of a groundwater monitoring well. To collect a sample, the Hydropunch is connected to a small-diameter driven pipe and is either driven or pushed hydraulically to the desired sampling depth. As the tool is advanced it remains in the closed position, which prevents soil or water from entering the Hydropunch sampling device. Once the desired sampling depth is reached, the tool is opened to the aquifer by pulling up the drive pipe approximately 1.5 feet. In the open position, groundwater can flow freely into the sample chamber of the tool. When the sample chamber is full, the Hydropunch is pulled to the surface. As the tool is retracted, check valves close and trap the groundwater in the sampler chamber. At the surface the sample is transferred from the Hydropunch to an appropriate sample container. The tool is a fast and inexpensive alternative for collecting groundwater samples from a discrete interval. This technology will also permit the completion of each sample hole as a piezometer, which will occur to aid in determining groundwater flow direction in the area between the seep area at Site 35 and the spring at Site 32.

6.2.3 Piezometer Installation

Piezometers, or small diameter monitoring wells, can be installed using a prepacked screen and associated PVC casing. Installation of the prepack monitoring well begins by advancing 2.125-inch outside diameter probe rods to depth using the direct push method. Prepacked screens are then assembled and installed through the 1.5-inch inside diameter of the probe rods using 0.5-inch PVC casing. The prepack tool assembly is attached to an expendable anchor point at the base of the probe rods. Once attached, the probe rods are slowly retracted to approximately 3 feet above the prepacked screen. At this time, the natural formation collapses to fill to void of the retracted probe rods. A grout barrier is installed in the annulus followed by a granular bentonite or bentonite slurry to form a well seal as the probe rods are slowly retracted. Once the well is set, conventional flush-mount or aboveground well protection can be installed to prevent tampering or damage to the well head (Geoprobe Systems 2002). The Hydropunch locations (up to 6) are shown on Figure 6.1-1 as locations H-M through H-R.

6.2.4 Conceptual Site Model Update

The CSMs will be updated upon receipt of the data collected from the Hydropunch investigation. It is expected that the newly acquired data will assist in delineating the nature and extent of the VOC plumes at Site 32 and Site 35. The fate and transport groundwater model will be revised to redefine the VOC plumes in terms of their migration rate and direction, dispersion and dilution, as well as their extent. As a result, the most appropriate location of the phytoremediation barrier and Treatability Study injection zone will be identified such that the remediation of the plumes at Sites 32 and 35 are appropriately addressed. In addition, the newly acquired data and modeling will assist in identifying the most appropriate locations for installing new monitoring wells

6.2.5 Groundwater Investigation Report

A groundwater investigation report will be written as a Technical Memorandum that will:

- Summarize Hydropunch groundwater investigation;
- Provide a revised CSM as an appendix, including groundwater modeling;
- Provide the final proposed location of the injection barrier associated with the Treatability Study at Site 35;
- Provide the final proposed location of the phytoremediation barrier associated with the IRA at Site 32; and
- Provide the proposed location of up to 20 monitoring wells to be installed at Sites 32 and 35 screened between approximately 14 feet below ground surface and bedrock. However, final screened intervals will be determined using data collected by the groundwater investigation.

6.3 SITE 32 INTERIM REMOVAL ACTION

This section presents a description of the activities associated with the phytoremediation barrier IRA. These activities include the phytoremediation barrier installation, watering, ET monitoring, monitoring well installation, monitoring well development and surveying, groundwater monitoring, and site restoration.

6.3.1 Initial Removal Action Activities

Initial removal action activities will prepare Site 32 for the installation of the phytoremediation barrier. These activities include weed and shrub abatement and procurement of willow trees. Weed and shrub abatement will be done in the immediate vicinity of each tree location. Weeds and shrubs will be removed to allow enough space for the willow tree to grow. The willow trees will be grown off-site in 5-gallon containers to allow root development in an unabated environment. This method will increase the survivability rate of the trees. Once the location of the phytoremediation barrier has been finalized, the planting grid will be established and marked in an offset pattern to allow for maximum interception of the TCE plume.

Prior to the removal action, a 30 SW Form 35, *Base Civil Engineer Work Request,* will be completed. This permit requires the notification and approval of the base Utilities shops and 30 Communications Squadron. Upon notification, these divisions will flag the location of utilities such as telephone, fiber-optic, and electric lines in the project area. The IRA at Site 32 and Treatability Study at Site 35 are not anticipated to disturb cultural or paleontological resources. Approval would be obtained from 30 CES/CEVPC (Cultural Resources) prior to the field activities.

6.3.2 Design of Phytoremediation Barrier

The proposed location of the phytoremediation barrier (Figure 6.1-1) was chosen based upon the location of the Site 32 plume, the location of Site 32 surface water seeps, the direction of groundwater flow, and the depth to groundwater. Ideally, the phytoremediation barrier will interdict across the downgradient extent of the plume where the TCE concentration is above the MCL (5 µg/L), be located where groundwater depth is shallower than 10 feet, and be upgradient of the impacted Site 32 spring. Thus, the barrier could then cut off the plume before it reaches the spring. A phytoremediation barrier placed across this area will be able to cut off the 5 µg/L plume prior to reaching the seep, since the groundwater depth is shallow enough for trees to effectively draw water directly from the water table, and the trees will be located directly downgradient of the plume. A total of up to 360 trees would be placed along this location at a spacing of roughly 15 feet. The groundwater extracted using these trees is designed to capture the Site 32 groundwater plume as depicted using the Site 32 and 35 Calibrated Groundwater Model discussed in Section 4 of this document.

It may be necessary to plant willows in an east-west pattern immediately above the spring if the groundwater investigation indicates that the groundwater from the Site 35 plume has a southerly direction and if there is any possibility that the Site 35 plume could impact the spring.

The project will not violate water quality standards or waste discharge requirements. The project is exempt from preparation and implementation of a Construction Activities Storm Water Pollution Prevention Plan (SWPPP) because the total acreage disturbed during installation of the remedy (0.8 acre) is less than one acre. Waste discharge requirements will not be violated by the project since there will be no water discharged other than the use of potable water via a hose to irrigate the willow trees. Over-irrigation of the phytoremediation barrier will not occur. Groundwater will not be allowed to discharge on the ground surface during well development activities.

The project will not have any affect on water supply wells or interfere with their groundwater recharge such that there would be a net deficit in aquifer volume. The nearest water supply wells are located in Barka Slough, approximately 6.5 miles southeast of the site. Groundwater at the site is not extracted for use a drinking water source. The willows planted to implement the remedy will likely lower the groundwater table along the remediation barrier with the ultimate goal of improving water quality downgradient of the barrier The discharge rate of downgradient springs downgradient of the barrier will likely be decreased significantly. However, the project will not adversely affect existing land uses or planned uses for which permits have been granted since water is supplied to cattle that graze in the area via the base potable water system.

There are no drainage channels where the phytoremediation barrier will be installed. Therefore, the phytoremediation project will not alter the existing drainage pattern of the area. The rate or amount of surface runoff will not be increased since the willow trees will not be over-irrigated. Thus, the project will not result in flooding on or off-site.

The proposed phytoremediation project is designed to improve rather than degrade water quality by removing chlorinated solvents in groundwater If successfully implemented, the contaminated groundwater will not discharge at the natural springs

6.3.3 Phytoremediation Barrier Installation

A mechanical auger will be used to create a boring approximately 4 feet deep and 2 feet in diameter. The tree will then be planted at a depth of 3 feet and the willow tips will extend 1 to 2 feet above the ground surface. The surrounding space will be backfilled with native soil. Remaining soil will be used to surround the willows to create an irrigation berm. This berm will help divert water towards the tree and its root system. The plants will be watered immediately after the initial planting. A probe adaptor, attached to the end of a hose, will be used to water each willow. This probe will be pushed into the soil near the root system of each tree, essentially watering the tree at depth. This will encourage the roots to grow downward.

After the trees are planted, an 8-foot fence will be placed around the phytoremediation barrier. This fence will be constructed to protect the trees from deer and other animals that may cause potential damage or hinder the growth of the willows.

For a period of 6 months, the groundwater levels in multiple wells will be monitored using a data logger to assess the effect of the phytoremediation barrier on the groundwater surface. During this time, a meteorological station at the site will record various parameters, which, when coupled with the groundwater level measurements, will permit calculation of the ET rates of the willows. This information will provide insight as to the irrigation schedule and the effectiveness of the phytoremediation barrier to address the TCE plume.

6.3.4 Monitoring Well Installation

Up to 10 monitoring wells are proposed to be installed throughout Site 32. The final locations of these wells will be determined based upon the Hydropunch investigation results and the final location of the phytoremediation barrier These proposed monitoring wells will assist in evaluating the effectiveness of the barrier and its ability to interdict the TCE plume as well as monitor the fluctuation in water levels correlated to the uptake of groundwater by the willow barrier. Pending data that will be obtained during the groundwater investigation, wells associated with monitoring the plume will be screened in the most contaminated zone of the aquifer. However, wells dedicated to monitoring fluctuations of groundwater levels will be screened straddling the groundwater table. A CME 75 Hollow Stem Auger (HSA) drilling rig or equivalent will be used to install each 4-inch-diameter groundwater monitoring well to an approximate depth of 30 feet bgs, approximately coincident with bedrock. The well screen and casing will be schedule 40 polyvinyl chloride (PVC). The well screen will extend across the water table, if practical, and consist of 10-foot-long sections of 0 010-inch slots filter pack will be 2/12 sand, similar to existing site wells. All grouts and seals will be placed by tremie pipe. A bentonite seal will be placed 3 feet above the screened interval. Portland cement/bentonite powder grout will be placed in the borehole annulus from the top of the bentonite seal to near ground surface. Surface completion of the monitoring well will be aboveground construction, including an embedded 5-foot-long, 10-inch-diameter steel well monument with a locking cap set approximately 2.5 feet into the ground. A 2-foot-square by 4-inch-thick (minimum) cement pad will be poured, sloping away from the monument. Four guard posts will be placed around the well completion to a depth of 2 feet, and cemented into place for crash protection. A survey marker will be set into the concrete apron at the time of construction.

After each monitoring well has been properly developed according to the Sampling and Analysis Plan (SAP) (U.S. Air Force 2003), each well will be fitted with a dedicated MicroPurge pump similar to that installed in well 35-MW-4. Well construction data, such as depth to water, and MicroPurge pump inlet depth will be provided in a Field Modification Report prepared after the groundwater investigation.

6.3.5 Monitoring Well Development

All new groundwater wells will be developed by bailing, surging, and purging in accordance with the Basewide SAP (U.S. Air Force 2003). Water from well development will be transferred into 55-gallon drums and transported to the Agena Tank Farm

6.3.6 Survey of New Well Locations

The positions of the new wells will be surveyed by a state licensed surveyor to provide a reference to their locations in the field using North American Datum (NAD) 1983 as the horizontal reference. The elevations of the top of the well casings will be surveyed to an accuracy of ± 0.01 foot, referenced to North American Vertical Datum (NAVD) 1988. A survey monument set in the concrete apron of each well completion will also be surveyed.

6.3.7 Site Restoration

Activities conducted during the IRA at Site 32 are expected to cause minimal impact to the terrain, biota, and general layout of the area. However, impacts that do occur will be addressed in order to return the site to the conditions present before field activities were initiated. Possible impacts may include damage to the grass and surrounding vegetation due to heavy equipment operation or potential alterations to any fencing that is used to contain livestock.

6.4 SITE 35 TREATABILITY STUDY

This section presents a discussion of the proposed Site 35 Treatability Study. The Treatability Study will test the effectiveness of a new technology to affect reduction in concentrations of chlorinated VOCs in the downgradient portion of the Site 35 groundwater plume.

6.4.1 Treatability Study Objective

The objectives of a Treatability Study are to provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analyses, to support the remedial design of a selected alternative, and reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a final remedy can be selected. This Treatability Study will assess the ability of emulsified soybean oil to enhance already semi-anaerobic conditions within a portion of the aquifer, resulting in the anaerobic degradation of TCE, *cis*-1,2-DCE, and vinyl chloride from groundwater. The area targeted for the emulsified soybean oil Treatability Study at the IRP Site 35 is shown on Figure 6.1-1, and is located approximately 200 feet upgradient of 35-MW-8. Well 35-MW-8 is characterized by slightly reducing conditions and contains TCE at concentrations ranging from hundreds to 1,200 µg/L and *cis*-1,2-DCE at concentrations ranging from 1 to 9.4 µg/L. Emulsified soybean oil was selected as a substrate due to its suitability with site characteristics. The shallow groundwater, the relatively small size of the contaminant plume, the lack of infrastructure in the vicinity of the contaminated area, evidence of ongoing slow or stalled reductive dechlorination, the aquifer characteristics (i.e., organic carbon content, hydraulic conductivity, etc.), as well as the concentration of sulfate present at the targeted treatment zone are all factors contributing to the selection of emulsified soybean oil as the proposed substrate.

Performance standards will provide key insight as to the overall effectiveness of the emulsified soybean oil injection process to induce an anaerobic environment favorable for reductive dechlorination. Essential transitions must occur in order for the environment to be suitable for degradation of chlorinated solvents. Key indicators are outlined as the following:

- Concentrations of the parent compound (TCE) are reduced;
- Dechlorination product (*cis*-1,2-DCE, *trans*-1,2-DCE, or vinyl chloride) concentrations are increased and do not demonstrate a buildup;
- Ethene and/or ethane is produced, even if in low concentrations;
- Metabolic transformation products are present (e.g. pyruvic, butyric, propionic acids);
- Total organic carbon (TOC) concentrations measurably increase above background indicating aquifer loading;
- Dissolved oxygen concentrations are less than 0.5 mg/L and ORP values are less than 0.0 mV; preferably in the -150 to -250 mV range;
- An increase in Fe(II) concentrations is observed with a reduction in competing electron acceptors (e.g. nitrates, sulfate, etc.);
- Methane is produced, indicating that fermentation is occurring and that the potential for complete dechlorination exists.

The indicators listed above form the performance standards that will be evaluated throughout the duration of the treatability study. These are designed to provide overlapping lines of evidence of the creation of reducing conditions in the targeted treatment zone and the resultant breakdown of TCE and its daughter products. Ultimately, the persistent decline of contaminant concentrations will provide the strongest evidence supporting the effectiveness of enhanced anaerobic bioremediation.

6.4.2 Treatability Study Design

The Treatability Study will involve completion of an initial benchscale program, installation of injection and monitoring wells, initial sampling of monitoring wells to establish pre-treatment (baseline) conditions, initial injection of emulsified soybean oil into injection wells, and sampling of selected monitoring wells at four quarterly intervals over the 12-month test period. It is expected that a transition from semi-anaerobic to anaerobic conditions, a reduction of TCE, and increase in TCE degradation products will be observed in newly installed monitoring wells immediately downgradient of the injection area within 3 sampling events of the initial treatment. The total duration of the Treatability Study is estimated to be approximately 1.5 years including time required for injection/monitoring well installation and development.

Potential problems that may arise when injecting emulsified soybean oil are identified in the following bullets:

- Decreased permeability of the aquifer as a result of oil clogging the pore spaces. Decreased permeability at the injection barrier can cause a plume to migrate around the barrier.
- Limited distribution Low injection pressures can result in preferential distribution in the upper injection zone, with little or no oil reaching the lower zone High injection pressures can create preferential pathways through aquifer fracturing.
- Achieving the optimal emulsion for distribution in the aquifer. State how the appropriate composition and oil droplet size will be determined and achieved
- Degradation of vegetable oil to methane Because vegetable oil can degrade directly to methane, there is a potential hazard from the accumulation of explosive concentrations in buildings and subsurface features (e.g., monitoring and injection wells).
- Incomplete dechlorination, resulting in the accumulation of daughter products This is a potential problem with any remedial system based on enhanced dechlorination.

To avoid the above referenced potential problems, the following approaches and solutions will be applied to site activities:

- The potential problem of decreased permeability of the aquifer resulting in oil clogging of the pore spaces may be avoided by following guidance outlined in Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents, Air Force Center for Environmental Excellence [AFCEE] August 2004. Emulsified soybean oil is to be injected as opposed to "neat" or undiluted oil. By reducing the oil droplet diameter size to about one micron (suitable for fine-grained sands and silts), clogging will be dramatically reduced.
- Limited distribution of the substrate will be avoided by using an emulsified soybean oil substrate and by applying the correct pressure needed to evenly distribute the soybean oil substrate without causing preferential pathways. The pressure is not expected to exceed the overburden pressure, as the substrate is a low viscosity fluid.
- The appropriate oil composition will be achieved by analysis of the benchscale test results. The anticipated composition of the substrate solution will most likely follow guidance as outlined in Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents, AFCEE August 2004; 5 to 10 percent by volume oil and emulsifier will be mixed with 90 to 95 percent of groundwater collected from Site 35.
- The degradation of vegetable oil is not expected to produce methane at concentrations above the lower exposure limit (LEL). However, during site activities methane concentrations will be monitored using a flame ionization detector (FID). If concentrations exceed action limits set forth in the site specific health and safety plan, appropriate action will be taken. In addition, stoichiometric equivalent volumes will be calculated prior to substrate injection in order to predict future concentrations of methane.
- Incomplete dechlorination, resulting in the production and potential accumulation of daughter products is a potential scenario for all microbially mediated sequential chemical reactions. It will be avoided by close monitoring of water parameters and analyses (dissolved oxygen, oxidation reduction potential, pH, chloride, sulfate, nitrate, alkalinity, sulfide, and total organic content) to ensure that an anaerobic environment is maintained. Proper guidance will be followed to achieve this goal.

Due to the use of an emulsifier and magnitude of dilution of the soybean oil, the potential for clogging will be minimized (AFCEE 1994). However, to evaluate this potential, the targeted portion of the aquifer will be evaluated by monitoring indicators associated with hydraulic conductivity in the treatment zone. A baseline aquifer slug test will be conducted to provide a background hydraulic conductivity for two wells (to be assigned after installation of the injection and monitoring wells) within the study area. The groundwater elevation will be closely monitored throughout the project in the injection wells and nearby monitoring wells to assess whether groundwater mounding (an elevation in the water table) persists following injection. Initial mounding is expected, as a relatively large volume of substrate will be introduced to the aquifer. If persistent mounding is present, indicating potential clogging problems, a second aquifer test will be completed. The hydraulic conductivity results will be compared to the baseline results to assess the potential presence and magnitude of clogging, if present

Based on the previous IRZ demonstration project implemented at Site 35 (Section 3.3), it appears that an overly aggressive injection program led to problems associated with controlling the transition from aerobic to anaerobic conditions. This led to acidic conditions, methanogenesis, and a stalled IRZ process. The proposed treatability study will specify injection of a stoichiometrically calculated mass of emulsified soybean oil substrate that is designed to slow the pace of transition to anaerobic conditions. A slow, sustained release of hydrogen from the emulsified soybean oil should effectively drive the IRZ process forward without causing acidification or significant production of methane.

6.4.2.1 Benchscale Study

A benchscale study will be performed in order to gain a greater understanding of the interface between the soybean oil and the aquifer media into which it will be injected. The benchscale study will provide an accelerated response to anaerobic remediation. Soil from Site 35 will be evaluated to determine whether it contains a natural population of bacteria that is suitable to perform the remediation, and also whether indigenous bacteria are able to respond to an increase in the biochemical energy and the hydrogen generated from the soybean oil substrate under the anaerobic conditions of the test. The benchscale test is expected to last for approximately 6 to 7 weeks, after which a report will be generated including interpretation of the test results and recommendations for field deployment.

The benchscale program will consist of three different tests described below. Native soil and groundwater from the site will be collected during the Hydropunch investigation and used in each of the three tests to support the benchscale program. The first test will utilize native soil and groundwater spiked with TCE at a concentration of 5,000 micrograms per liter (µg/L). No emulsified soybean oil will be added to this batch; it will be used as a control. The second test will utilize native soil and groundwater spiked with TCE at a concentration of 5,000 µg/L, with the addition of an emulsified soybean oil substrate. The substrate will be comprised of 10 percent soybean oil and emulsifier by volume with a droplet size of approximately one micron mixed with 90 percent native groundwater by volume. The third test will utilize the same variables as the second test with the addition of *Dehalococcoides ethenogenes*. These three tests will be monitored by the subcontractor and a report will be generated showing the effects of emulsified soybean oil and *Dehalococcoides ethenogenes* on the degradation of TCE under anaerobic conditions. The findings of the test will be applied to further delineate unknown variables (such as required mass of the substrate, the dosage rate, and the injection pressure) of the treatability study.

6.4.2.2 Soybean Oil Injection Process

This injection process involves the application of food grade, emulsified soybean oil via injection wells into the aquifer. Naturally occurring microorganisms would utilize the soybean oil as a carbon and energy source to produce hydrogen necessary for reductive dechlorination. Soybean oil has low viscosity, which allows a greater volume of substrate to be applied in a shorter period of time than with other substrates, thus increasing the radius of influence. Soybean oil has been successfully applied as a reactive barrier to retard plume migration. In order to rapidly create anaerobic conditions in the targeted treatment zone, a lactic acid solution, or "primer" will be added to the injected solution. An emulsifier will also be added in order to increase the solubility of the soybean oil in the groundwater In addition, bromide will be added as a tracer to further profile the migration pattern of the injected solution The chemical compositions of the ingredients making up the injected substrate solution are as follows:

Soybean Oil: $C_{56}H_{100}O_6$

Lactic Acid: $CH_3CHOHCO_2H$

The emulsifier will most likely be lecithin, which is defined as a group of phospholipids and does not have a definitive chemical composition

After proper mixing the calculated ratios of soybean oil, emulsifier, primer, and tracer to produce a substrate, it is expected that only one injection would take place for the purposes of the Treatability Study The injection dosage rate will be determined based on numerous factors, such as the site hydrogeology, geochemistry, and injection well design. The mass of soybean oil substrate estimated to be injected must release sufficient hydrogen to accommodate the competing electron acceptor load and calculated mass of VOCs in the targeted treatment zone over a specified duration.

Due to the use of an emulsifier and magnitude of dilution of the soybean oil, the potential for clogging will be minimized (AFCEE 2004). However, to evaluate this potential, the targeted portion of the aquifer will be evaluated by monitoring indicators associated with hydraulic conductivity in the treatment zone. A baseline aquifer slug test will be conducted to provide a background hydraulic conductivity for two wells (to be assigned after the installation of the injection and monitoring wells) within the study area. The groundwater elevation will be closely monitored throughout the project in injection wells and nearby monitoring wells to assess whether groundwater mounding (an elevation in the water table) persists following injection. Initial mounding is expected, as a relatively large volume of substrate will be introduced to the aquifer. If persistent mounding is present, indicating potential mounding problems, a second aquifer slug test, conducted following the same protocol as the baseline test, will be completed. The hydraulic conductivity results will be compared to the baseline results to assess the potential presence and magnitude of clogging.

6.4.2.3 Injection Well Equipment

The soybean oil injection equipment will be mounted on a stakebed truck supplied by Vironex Environmental Field Services (Vironex). The equipment includes one R.E. RUPE Company Model 91500 mixing pump (Rupe pump) with 40-gallon capacity hopper capable of pumping product at a maximum of 9 gallons per minute (gpm) at pressures up to 1,500 pounds per square inch (psi) and an injection hose/product line (0.75-inch inside diameter) connected to an inflatable packer. The mobile injection unit utilized by Vironex has the capability of injecting large quantities of remedial compounds (soybean oil). A specifically designed pumping system can pump at rates ranging from 2.3 gpm at 1,000 psi for smaller projects, and up to 40 gpm at 500 psi, or 9 gpm at 1,500 psi for larger projects. Vironex uses specially designed injection tools that allow injection of compounds at a variety of target depths. In addition to the injection tools, they are also equipped with a check valve assembly to eliminate back pressure that may occur while retracting the drive rod out of the borehole. This combination of tooling allows for a cleaner and more precise injection process. The injection hose will be connected to an inflatable packer. The hose and packer will be lowered into each well and the packer will be inflated above the screened interval of each well prior to injecting the soybean oil substrate. Although the Rupe pump is capable of pumping product at pressures up to 1,500 psi, the actual subsurface injection pressure will be dependent on subsurface conditions encountered in the field during product delivery.

6.4.2.4 Injection Well Installation

Up to 20 injection wells, spaced at approximately 10 to 20 feet intervals are proposed to comprise the injection well array The basis for proposed well spacing of between 10 to 20 feet results from the lack of distribution of substrate achieved by ARCADIS during the molasses injection and from recommendations in guidance documents (AFCEE 2004). Gaps of IRZ influence existed downgradient of injection wells 35-I-2 and 35-I-3 (spaced at 20 feet) approximately 14 months into operation of the IRZ project in April 2002 (Attachment 1 of Appendix E in the response to RWQCB comments). In addition, AFCEE guidance recommends a well spacing of between 5 and 15 feet between injection point centers (AFCEE 2004). In light of the ARCADIS data and AFCEE guidance, a well spacing of between 10 and 20 feet was assigned; with likely well spacing closer to 10 feet.

The borings for the proposed injection wells will be drilled to approximately 35 feet bgs, coincident with the top of the Sisquoc Formation bedrock (or upper weathered bedrock surface) using a CME 75 HSA drilling rig, or its equivalent. A 2-inch-diameter, Schedule 80 PVC well will be installed in 8-inch-diameter boreholes. The injection well screened intervals will be nominally from 20 to 35 feet bgs. For the screened interval of each injection well, 2/12 sand will be used as the filter pack. The size of the slots for the injection well screens will be 0.02 inch to allow for efficient product delivery A bentonite seal of at least 5 feet in thickness will be installed at the top of each well's screened interval in order to minimize the possibility of short-circuiting during soybean oil injection. Above the upper bentonite seal, the well annulus will be filled with Portland cement/bentonite grout to the surface. All grouts and seals will be placed by tremie pipe

Surface completion of the monitoring well will be aboveground construction, including an embedded 5-foot-long, 10-inch-diameter steel well monument with a locking cap set approximately 2.5 feet into the ground. A 2-foot-square by 4-inch-thick (minimum) cement pad will be poured, sloping away from the monument. Four guard posts will be placed around the well completion to a depth of 2 feet, and cemented into place for crash protection. A survey marker will be set into the concrete apron at the time of construction.

6.4.2.5 Monitoring Well Installation

Monitoring wells at Site 35 will be installed to monitor the injection barrier and to augment the existing monitoring network to enhance groundwater plume delineation. Based on results obtained from the groundwater investigation, the monitoring wells will be screened across the highest contaminated zone of the aquifer A CME 75 HSA drilling rig will be used to install up to 10 proposed 4-inch-diameter groundwater monitoring wells at Site 35. The screened interval will be from approximately 10 to 25 feet bgs in shallower sediments and between 30 and 45 feet bgs in deeper sediments, or to the top of bedrock (or upper weathered bedrock surface) in each case. Treatability Study monitoring wells will be screened across the same interval(s) targeted for injection. Plume monitoring wells will be screened near bedrock, if DNAPL is suspected, or across the water table for dissolved phase groundwater monitoring.

The 4-inch-diameter screen and casing will be schedule 40 PVC. Casing screen will be 0.01-inch slot. All grouts and seals will be placed by tremie pipe. A bentonite aquifer isolation seal will be placed between the top of the screened interval to at least 3 feet above the screened interval Portland cement/bentonite powder grout will be placed in the borehole annulus from the top of the bentonite seal to the top of the water table to the ground surface.

Surface completion of the monitoring well will be aboveground construction, including an embedded 5-foot-long, 10-inch-diameter steel well monument with a locking cap set approximately 2.5 feet into the ground. A 2-foot-square by 4-inch-thick (minimum) cement pad will be poured, sloping away from the monument. Four guard posts will be placed around the well completion to a depth of 2 feet, and cemented into place for crash protection. A survey marker will be set into the concrete apron at the time of construction.

After the newly installed monitoring wells have been properly developed according to the Basewide Sampling and Analysis Plan (SAP) (U.S. Air Force 2003), the well will be fitted with a dedicated MicroPurge pump similar to that installed in well 35-MW-8.

During the installation of monitoring wells at Site 35, up to eight soil core samples will be collected from the well borings to aid in defining the fate and transport component of the site model. The soil samples will be analyzed for total porosity, grain size analysis, effective porosity, hydraulic conductivity, total organic carbon, specific gravity, and moisture density by Keantan Laboratories located in Santa Fe Springs, California. Data management, analysis, and validation as well as residuals management, transportation, and disposal will be adhered to as outlined in Sections 7 and 8, respectively.

6.4.2.6 Well Development

All new groundwater wells including the 20 injection wells will be developed by bailing, surging, and purging in accordance with the Basewide SAP (U.S. Air Force 2003). Well development and purge water will be transferred into 55-gallon drums and transported to the Agena Tank Farm.

6.4.2.7 Survey of New Well Locations

The positions of the new wells will be surveyed by a state licensed surveyor to provide a reference to their locations in the field using NAD 1983 as the horizontal reference. The elevations of the top of the well casings will be surveyed to an accuracy of $\pm$ 0.01 foot, referenced to NAVD 1988. A survey monument set in the concrete apron of each well completion will also be surveyed.

6.4.3 Initial Baseline Sampling

At least 72 hours after new well development, the new Site 35 monitoring wells will be purged and sampled using a MicroPurge pump. Monitoring wells located upgradient of the treatment area will provide a measure of contaminant mass and competing electron acceptor load entering the treatment area. Wells downgradient of the treatment area will be sampled to provide baseline information on geochemical conditions prior to injection of the soybean oil. Groundwater samples from the wells will be analyzed for a suite of constituents using the following U.S. EPA methods: SW8260B for VOCs; E300.0 for chloride and sulfate; E353.2 for nitrate; E310.1 for alkalinity; E376.2 for sulfide; E415.2 for total organic carbon (TOC); SW3810M for methane, ethane, and ethene; and ion chromatography for metabolic acids (lactic, pyruvic, acetic, and propionic). In addition, field tests collected from the ten monitoring wells will include pH, temperature, electrical conductivity, turbidity, ORP, Fe II, and DO. Results of these tests will form a baseline against which to compare analytical data for samples collected after initiation of the injection program.

6.4.3.1 Treatability Study Data Interpretation

Metabolic Transformation Products

The soybean oil substrate is designed to slowly release hydrogen atoms to groundwater based on degradation pathways over the period of many months to years. The soybean oil degrades to fatty acids and glycerol. It is the breakdown of the fatty acids into acetate, which further breaks down into carbon dioxide, which releases hydrogen.

Volatile Organic Compounds

Concentrations of TCE, *cis*-1,2-DCE, vinyl chloride, methane, ethane, and ethene will be tracked to assess their potential breakdown and/or generation. Concentrations of *cis*-1,2-DCE and vinyl chloride are expected to increase as concentrations of TCE are decreased over the course of the Treatability Study. Breakdown products in the successful destruction of these site contaminants are ethene and/or ethane. Therefore, ethene and/or ethane levels are expected to increase as a result of successful anaerobic dechlorination.

Competing Electron Acceptors

When the soybean oil substrate is applied to a contaminated groundwater setting, it supplies hydrogen as an electron donor to the anaerobic dechlorinating microbes responsible for the desired degradation. The contaminant in this suite of reactions is the electron acceptor, taking the electron from the bacterium and consequently being dechlorinated. This set of reactions, however, is complicated by the presence of competing electron acceptors (CEAs). Common CEAs are oxygen, nitrate, iron, and sulfate. The concentration of CEAs will be tracked throughout the study. Site conditions currently show that oxygen (<1 mg/L), nitrate (non-detect), and Fe II levels (7.5 parts per million) will not significantly compete for electrons. However, current sulfate levels are high (>200 mg/L), resulting in an increase in demand for the electron donor hydrogen, as it is used through various reactions.

MNA Parameters

Numerous physical and chemical groundwater parameters will be measured in site groundwater samples to assess the potential for biodegradation of chlorinated aliphatics as a component of MNA. These MNA parameters include laboratory measurements of chloride, nitrate, sulfate, alkalinity (as calcium carbonate), TOC, total sulfide, and field measurements of pH, DO, ORP, temperature, and Fe II. The MNA parameters for each well will be evaluated to assess the likelihood that biodegradation is occurring. The MNA screening methodology is described in *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (U.S. Air Force 1998). As the soybean oil releases hydrogen to groundwater over the study period, subsurface conditions will be monitored for changes in concentrations of these geochemical parameters and compared to the levels listed as conducive to anaerobic biotransformation

In general, the following parameters indicate favorable conditions for reductive dechlorination:

- DO (<0.5 mg/L);
- Nitrate (<1 mg/L);
- Fe II (>1 mg/L);
- Sulfate (<20 mg/L);
- Sulfide (>1 mg/L);
- Methane (>0.5 mg/L);

- ORP (<-100 millivolts);
- pH (5<pH<9);
- TOC (>20mg/L);
- Temperature (>20 degrees Celsius);
- Alkalinity (> twice background);
- Chloride (>twice background); and
- Ethene/ethane (>0.01 mg/L).

6.4.4 Site Restoration

Activities conducted during the Treatability Study at Site 35 are expected to cause minimal impact to the terrain, biota, and general layout of the area. However, impacts that do occur will be addressed in order to return the site to the conditions present before field activities were initiated. Possible impacts may include damage to the grass and surrounding vegetation due to heavy equipment operation or potential alterations to any fencing present which contains livestock.

6.5 SITE 32 AND SITE 35 OPERATION AND MAINTENANCE

This section will provide details outlining the operation and maintenance activities that will be performed during the phytoremediation IRA at Site 32 and the Treatability Study at Site 35.

6.5.1 Site 32 IRA Phytoremediation Barrier Maintenance

The willow trees composing the phytoremediation barrier at Site 32 will require routine maintenance in order to ensure optimal growth and overall success in the project for only the duration of time required for the tree roots to reach the water table. Primary maintenance activities will include watering and weed abatement. Weed abatement will be performed, as necessary, in the immediate vicinity of each willow tree. Watering will be conducted by the contractor immediately after the initial planting of the willows, and then monthly for 4 months. The trees will not be watered to the extent they receive more moisture than the calculated ET rate. The trees may need to be watered more frequently if adverse growing conditions, such as drought or excessive heat, occur. In this case, watering will be completed as necessary to ensure the survival of the willow trees. Weed abatement will be performed, as necessary, during watering activities

6.5.2 Water Level Monitoring Program at Site 32

For a period of up to six months, the groundwater levels will be monitored in multiple wells to assess the effect of the phytoremediation barrier on the groundwater. Water level monitoring will be conducted using a series of pressure transducers and a data logger. It is envisioned that a measurable drop in water table elevation will occur as a result of plant uptake in the vicinity of the phytobarrier. Based on groundwater levels as well as data collected by the meteorological station, ET rates will be estimated. The data will help determine the effectiveness of the phytoremediation barrier to address the TCE plume. It is important that this phase of the project be initiated after it is apparent that the tree roots have intercepted the groundwater table. This period is estimated to be from March 2006 through August 2006.

6.5.3 Treatability Study Monitoring Program at Site 35

Four quarterly sampling events will follow the soybean oil injection event. Field monitoring parameters will include water level, pH, temperature, specific conductance, turbidity, DO, ORP, and Fe II. Fixed laboratory analyses will include the following U.S. EPA methods: SW8260B for VOCs, E300.0 for chloride and sulfate; E353.2 for nitrate; E310.1 for alkalinity; E376.2 for sulfide; E415.2 for TOC; SW3810M for methane, ethane, and ethene; and metabolic acids via ion chromatography.

Anticipated changes to groundwater conditions in the treatment zone following soybean oil injection include (1) a transition from semi-anaerobic to anaerobic conditions based on key monitoring parameters (e.g., ORP, DO, and reduced forms of alternate electron acceptors); (2) the generation of *cis*-1,2-DCE with a corresponding decline in TCE concentrations; (3) the generation of vinyl chloride and/or ethene/ethane with a corresponding decline of *cis*-1,2-DCE concentrations; or (4) a decline in vinyl chloride and *cis*-1,2-DCE concentrations.

6.5.4 Post-Phytoremediation Barrier Installation Monitoring Program at Site 32

Monitoring wells, installed as part of the phytoremediation barrier IRA, will be sampled on the same quarterly sampling schedule as the Site 35 Treatability Study. Field monitoring parameters will include water level, pH, temperature, specific conductance, turbidity, DO, ORP, and Fe II. Fixed laboratory analyses will be limited to U.S. EPA method SW8260B for VOCs to assess the uptake of TCE by the willow trees.

Anticipated changes to groundwater conditions in the treatment zone following installation of the phytoremediation barrier include (1) a decline in local groundwater elevation; and (2) the decline of TCE concentrations as groundwater migrates through the phytoremediation barrier. It is anticipated that these two changes will not take place until the third quarterly monitoring event due to the time required for development of the root systems.

6.5.5 Quarterly Monitoring Reports

Tetra Tech will prepare and submit four quarterly technical memoranda containing all data collected during the IRA and Treatability Study. The reports will include a description of field activities, photographic documentation, analytical data, and recommendations. The first quarterly report will include both the baseline monitoring at Sites 32 and 35 and the first quarterly sampling event, a summary of the benchscale testing, and a summary of the implementation of the Site 32 IRA and Site 35 Treatability Study. Tetra Tech will report the results of the sampling, water level measurement, and interpretation. The final quarterly report will be comprehensive report including a summary of all activities conducted for the entire Treatability Study and IRA, and recommendations. The monitoring and reporting for the IRA will continue through the Basewide Groundwater Monitoring Program (BGMP) on a semiannual basis. The progress of the phytoremediation barrier will be documented in the BGMP reports. This time period will allow a longer time range to evaluate the effectiveness of the barrier.

6.6 PROTECTION OF HUMAN HEALTH

6.6.1 Worker Health and Safety Plan

Health and safety information and procedures required to conduct field work at the Site 32 Cluster are provided in the Health and Safety Plan Addendum in Appendix C. The addendum is intended to augment the following documents: Installation Restoration Program RI/FS Health and Safety Plan (JEG 1993b), the Tetra Tech Corporate Health and Safety Manual (Tetra Tech 1999), the Basewide SAP (U.S. Air Force 2003), and previous training received by field participants. The above-mentioned documents are available for review or reference at the Tetra Tech field trailer, located at the Agena Tank Farm Investigation-Derived Waste (IDW) Storage Area at Vandenberg AFB, and in the Tetra Tech Santa Barbara, California, office.

7.0 RESIDUALS MANAGEMENT

Residuals will be managed in accordance with the following:

- *Vandenberg Air Force Base, Waste Management Plan Addendum* (U S. Air Force 2005);
- *Handbook to Support the Installation Restoration Program (IRP), Statement of Work, Volume 1 – Remedial Investigation/Feasibility Study (RI/FS)* (U.S. Air Force 1991);
- *Hazardous Waste Management Plan* (U.S. Air Force 2002);
- *Wastewater Management Plan* (U S. Air Force 2000a); and
- *Solid Waste Management Plan* (U.S Air Force 2000b).

7.1 INVESTIGATION-DERIVED WASTE STREAMS

The quantity of IDW generated during the Site 32 and Site 35 supplemental groundwater investigation, the Site 32 IRA, and the Site 35 Treatability Study is estimated to include up to 23.5 cubic yards of soil and up to 7,495 gallons of monitoring well purge water, well development water, and decontamination wastewater. This estimated volume of water is based on the assumption that there will be a total of ten (baseline plus four quarterly events at Sites 32 and 35) sampling events. The actual amount of IDW generated may vary, as different hydrogeologic conditions may be encountered.

7.1.1 Soil

An estimated volume of approximately 23.5 cubic yards of soil waste will be generated during the supplemental groundwater investigation, the Site 32 IRA, and the Site 35 Treatability Study.

7.1.1.1 Supplemental Groundwater Investigation

A minimal amount of soil will be generated during the supplemental groundwater investigation. Soil cuttings will only be generated from the six proposed piezometer locations. Assuming the boring is 2 inches in diameter with a depth of approximately 10 feet, the amount of soil waste generated will be approximately 0.03 cubic yard. This volume includes a 20 percent soil expansion factor. No soil will be generated using the Hydropunch technology for the remaining sampling locations. Soil waste will immediately be transferred to a lined and labeled 15 cubic yard roll-off bin located on-site. Representative samples will be collected and analyzed to characterize the soil for disposal

7.1.1.2 Site 32 IRA

For purposes of estimating soil IDW volumes, ten well borings are assumed. Assuming that the average depth of wells installed at the site is approximately 30 feet with a 10-inch borehole, the total volume of soil removed will be approximately 7 cubic yards. This volume includes a 20 percent soil expansion factor.

7.1.1.3 Site 35 Treatability Study

For purposes of estimating soil IDW volumes, 20 injection well borings and 10 monitoring well borings are assumed. Assuming that the average depth of injection wells installed at the site is approximately 25 feet with an 8-inch borehole, the total volume of soil removed will be approximately 7.8 cubic yards. Assuming that the average depth of monitoring wells installed at the site is approximately 35 feet with a 10-inch borehole, the total volume of soil removed will be approximately 8.4 cubic yards. In total, 16.2 cubic yards of soil IDW is estimated. This volume includes a 20 percent soil expansion factor.

7.1.2 Groundwater

Approximately 5,945 gallons of waste groundwater will be produced during the supplemental groundwater investigation, the Site 32 IRA, and the Site 35 Treatability Study, including all sampling events.

7.1.2.1 Supplemental Groundwater Investigation

The Hydropunch sampling technique employed collects a limited amount of sample volume. Therefore, it is estimated that a small amount of residual sample volume may be produced during the groundwater investigation. It is estimated that approximately 5 gallons of IDW water will be generated during the sampling event. All IDW groundwater generated during Site 32 Cluster groundwater investigation activities will be temporarily placed in labeled 55-gallon polyethylene drums. The drums containing IDW water will be transported regularly to an 8,000-gallon holding tank at the Agena Tank Farm.

7.1.2.2 Site 32 IRA

Based on data collected while developing well 32-MW-7, it is estimated that up to approximately 200 gallons of water will be removed from each newly installed well prior to purging and sampling, totaling approximately 2,000 gallons for 10 wells. During sampling activities, it is estimated that approximately 10 gallons of purge water will be generated for each sampling round, totaling 50 gallons for the five sampling events. The actual amount of groundwater removed during development and purging operations will depend on the hydrogeology at each well location.

7.1.2.3 Site 35 Treatability Study

Based on data collected while developing well 35-MW-6, it is estimated that up to approximately 140 gallons of water will be removed from each newly installed monitoring well, totaling 1,400 gallons for 10 wells. The volume of each injection well will be approximately 4.89 gallons; assuming a 15-foot water column, approximately 122 gallons will generated during injection well development if 25 volumes are purged. The total wastewater generated from the injection well development is estimated to be 2,440 gallons. A total of 3,840 gallons will be purged during development activities. During sampling activities, it is estimated that approximately 10 gallons of purge water will be generated for each sampling round, totaling 50 gallons for the five sampling events. The actual amount of groundwater removed during development operations will depend on the hydrogeology at each well location.

7.1.3 Decontamination Waste

Approximately 1,550 gallons of decontamination wastewater will be produced during the supplemental groundwater investigation, the Site 32 IRA, and the Site 35 Treatability Study.

7.1.3.1 Supplemental Groundwater Investigation

Drilling rig equipment and sample collection equipment will be thoroughly decontaminated in accordance with the Waste Management Plan Addendum (U.S. Air Force 2005) prior to use. Hexane and methanol rinsates are not expected to be used during groundwater investigation activities. It is estimated approximately 50 gallons of decontamination wastewater will be produced during the sampling event. Wastewater generated from decontamination activities will be temporarily stored in labeled 55-gallon drums and transferred regularly to the holding tank at the Agena Tank Farm.

7.1.3.2 Site 32 IRA

Drilling rig equipment, monitoring well development equipment, purge equipment, and sample collection equipment will be thoroughly decontaminated in accordance with the Waste Management Plan Addendum (U.S. Air Force 2005) prior to use. Hexane and methanol rinsates are not expected to be used during the IRA field activities. Approximately 500 gallons of wastewater may be generated from decontamination activities.

7.1.3.3 Site 35 Treatability Study

Drilling rig equipment, monitoring/injection well development equipment, purge equipment, and sample collection equipment will be thoroughly decontaminated in accordance with the Waste Management Plan Addendum (U.S. Air Force 2005) prior to use. Hexane and methanol rinsates are not expected to be used during the Treatability Study field activities. Approximately 1,000 gallons of wastewater may be generated from decontamination activities.

7.1.4 Sludge Residue

After 55-gallon drums are emptied into the Agena Tank Farm holding tank, the remaining sludge residue will be consolidated into as few drums as possible. The sludge will be transferred to the labeled soil IDW bins and disposed of along with the soil. Approximately one 55-gallon drum of consolidated sludge residue will be generated during each phase of field activities, totaling three drums. No sludge will be produced during the quarterly sampling events. The actual amount of sludge generated may vary depending on the geology encountered as new monitoring wells are installed.

7.2 APPLICATION OF REGULATIONS

Investigation derived waste at Vandenberg AFB will be managed in accordance with applicable regulatory standards, requirements, criteria, and guidelines presented in the Waste Management Plan Addendum (U.S. Air Force 2005). This plan includes protocols for labeling, transportation, and storage of IDW.

7.2.1 Classification Of Investigation-Derived Wastes

In accordance with the classifications and guidelines presented in the Waste Management Plan Addendum (U.S. Air Force 2005), a determination will be made whether the IDW contains hazardous substances, and whether the hazardous substances are present at levels or in quantities that constitute Resource Conservation and Recovery Act (RCRA) hazardous wastes, Title 22 and 23 California Code of Regulations (CCR) wastes, or materials regulated under other statutes. This determination will be made by performing fixed laboratory analysis of representative waste samples

7.2.2 Waste Soil Analysis Requirements

Soil cuttings and groundwater IDW are typically characterized by samples collected during drilling or monitoring well sampling operations (U.S. Air Force 2000a). Since soil samples collected from the soil borings during installation of the wells at Sites 32 and 35 will not be analyzed for potential site contaminants, representative samples will be collected from each soil bin at the end of the field activities. The soil samples will be analyzed for potential site contaminants, including VOCs It is expected that all soil, sediment sludge, and residue generated during the supplemental groundwater investigation, IRA, and Treatability Study will be consolidated and disposed of at the Vandenberg AFB landfill in accordance with the guidelines presented in the Waste Management Plan Addendum.

7.2.3 Waste Water Analysis Requirements

Groundwater analytical results obtained from each groundwater sampling event will be used to profile the IDW water generated from decontamination of sampling equipment and residual sample volume. The IDW water collected from each groundwater investigation is expected to be a small volume (approximately 50 gallons) and will be consolidated into the 8,000-gallon holding tank at the Agena Tank Farm. Waste characterization samples will be collected from the holding tank under the BGMP and in accordance with the Wastewater Management Plan (U.S. Air Force 2000b). Based on previous characterization of IDW water generated from the Site 32 Cluster, the IDW water generated during the groundwater investigation is expected to be well below RCRA or CCR Title 22 hazardous waste criteria. Therefore, all IDW liquid generated during the groundwater investigation will likely be disposed of at the Vandenberg Industrial Wastewater Treatment Plant (IWTP).

7.3 RECORD KEEPING

All movement and storage of IDW soil, sludge, and water will be documented in a field logbook and entered into an electronic IDW inventory The electronic IDW inventory tracks volumes of soil cuttings, sludge, purge water, well development water, and decontamination wastewater. Written records will document the total purge volumes for each monitoring well.

8.0 QUALITY ASSURANCE PROJECT PLAN ADDENDUM

For laboratory analytical samples, data storage and documentation will be maintained using logbooks, data sheets, and computer files kept at Applied Physics & Chemistry Laboratories (APCL) APCL is located Chino, California. All computer generated raw data are stored on magnetic tape, or other media, and will be maintained along with all paper copies for not less than 5 years. All laboratory data management procedures, analytical methods, detection limits, quality assurance/quality control (QA/QC) procedures, and data validation procedures will be in accordance with the Final Basewide SAP

Standard analytical methods to be used for the sample analyses are referenced in the following documents:

- *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, SW-846, 3rd Edition Updates (U.S. EPA 1996); and
- *Methods for Chemical Analysis of Water and Wastes* (U.S. EPA 1993).

This Quality Assurance Project Plan (QAPP) Addendum summarizes the data gathering methods to be performed specifically in support of the Site 32 and Site 35 supplemental groundwater investigation, the Site 32 IRA, and the Site 35 Treatability Study. All new monitoring wells associated with the IRA and Treatability Study will be outfitted with Micropurge pump systems. Field methods, sampling procedures and analytical methods will be adhered to as outlined in the *Final Basewide Quality Assurance Project* (U.S. Air Force 2003). Table 8.0-1 outlines the analysis plan to be conducted over the course of the Supplemental Groundwater Investigation, the implementation of the Site 32 IRA and the Site 35 Treatability Study, and the Site 32 and 35 Monitoring and Reporting phase of site activities. Containers, sample preservations, holding times, field measurements, labeling, packaging, shipping, and chain-of-custody protocols will be followed as outlined in the *Final Basewide Quality Assurance Project* (U.S. Air Force 2003).

8.1 SUPPLEMENTAL GROUNDWATER INVESTIGATION

It is estimated that up to 35 groundwater samples will be collected throughout Site 32 and Site 35 using Hydropunch technology. The sampling locations, illustrated on Figure 6.1-1, will be analyzed for VOCs using U.S. EPA method SW8260B. Ten percent of the samples will be collected as duplicate samples, and five percent will be collected as matrix spike/matrix spike duplicate samples. All field sampling procedures and analytical methods will be adhered to as described in detail in the *Final Basewide Quality Assurance Project Plan* (U.S. Air Force 2003).

8.2 SITE 32 INTERIM REMOVAL ACTION

During monitoring well installation at Site 32, lithology will be logged approximately every 10 feet, and at lithologic changes. Samples will be collected using 2-inch split spoon samplers driven into place with a drop hammer. Boring logs will be generated based on notes recorded during site activities. No soil samples will be collected from the borings for chemical analysis during well installation.

During the quarterly monitoring, field monitoring parameters will include water level, pH, temperature, specific conductance, turbidity, DO, ORP, and Fe II. Fixed laboratory analyses will be conducted by Applied Physics & Chemistry Laboratories, a state-certified analytical laboratory, and will include U.S. EPA method SW8260B for VOCs. All field sampling procedures and analytical methods will be adhered to as described in detail in the *Final Basewide Quality Assurance Project Plan* (U.S. Air Force 2003).

8.3 SITE 35 TREATABILITY STUDY

During drilling for monitoring well installations at Site 35, soil core samples will be collected for logging purposes approximately every 10 feet, and at lithologic changes. Samples will be collected using 2-inch split spoon samplers driven into place with a drop hammer Boring logs will be generated based on notes created during site activities Up to eight soil core samples will be collected from the saturated zone and reserved for analysis of total porosity, grain size analysis, effective porosity, hydraulic conductivity, TOC, specific gravity, and moisture density (Table 8.0-1).

During injection well installation, lithologic logging will be conducted on drill cuttings; soil samples will not be collected for chemical analysis However, detailed well construction logs will be generated based on field notes gathered during site activities.

During the quarterly monitoring, field monitoring parameters will include water level, pH, temperature, specific conductance, turbidity, DO, ORP, and Fe II. Fixed laboratory analyses will include the following U.S. EPA methods: SW8260B for VOCs, E300 0 for chloride and sulfate; E353.2 for nitrate; E310 1 for alkalinity; E376.2 for total sulfide; E415.2 for TOC; SW3810M for methane, ethane, and ethene; and metabolic acids (Table 8.1). All field sampling procedures and analytical methods will be adhered to as described in detail in the *Final Basewide Quality Assurance Project Plan* (U.S. Air Force 2003).

Data validation will be performed by Tetra Tech on a minimum of 10% of the samples analyzed for VOCs via EPA method 8260B, using a modified Level II in accordance with the Basewide SAP (U.S. Air Force, 2003). The data validation process will primarily consist of reviewing sample hold times, laboratory and field blank results, laboratory control samples, surrogate recoveries, sample receiving temperature, relative percent differences between field duplicate and replicate duplicate results, and corrective actions performed in response to data or conditions that are not under analytical control.

9.0 PUBLIC INVOLVEMENT

Vandenberg AFB is involved in numerous activities to keep the public informed of investigative activities at the facility. This section discusses current involvement with the community as well as anticipated participation regarding the RAW.

9.1 CURRENT PARTICIPATION

This section describes programs affecting the public in which Vandenberg AFB is involved on a regular and continuous basis.

9.1.1 IRP-Community Involvement

Part of the IRP includes developing a Community Involvement Plan (CIP). The purpose of the CIP is to document community background and concerns regarding cleanup, and to identify specific activities that will meet community involvement goals by (1) providing timely information about cleanup efforts and (2) establishing opportunities for two-way communication between communities and the base.

The most significant avenue the base uses to facilitate cleanup information is through quarterly meetings with its Community Advisory Board (CAB) members. Members of the CAB represent the public at large and act as a liaison between the base and their respective communities. Vandenberg AFB uses the CAB to inform members and the public about the many methods used in IRP studies and cleanup effort findings. Vandenberg AFB also uses this forum to inform the CAB and the public about other environmental issues including environmental compliance, pollution prevention, conservation, and restoration programs. Community involvement activities also include interviews with local educators, residents, and business people and distribution of newsletters, fact sheets, and brochures. A comprehensive mailing list is continuously updated and includes local community members; federal, state, and local officials; local media; and others who have expressed interest in reviewing information about the Vandenberg AFB cleanup program. Information repositories have been established at the Vandenberg AFB Library, the Lompoc Public Library, the Cypress DTSC, and the San Luis Obispo RWQCB. The repositories include IRP work plans, technical reports, summary documents, and other information of public interest (e.g., fact sheets and news releases).

9.1.2 Community Advisory Board Document Review Subcommittee

An important component of the CAB is the document review subcommittee. This committee is responsible for reviewing and providing comments on draft documents, fact sheets, and plans before they are released to the general public. As required, the Air Force provides the group with copies of the draft documents and gives them approximately 2 weeks for comment

9.2 PLANNED PARTICIPATION FOR THE RAW

The planned public participation schedule for the IRA at Site 32 and Treatability Study at Site 35 is shown in Figure 1.4-1. A fact sheet will be prepared that describes the major points of the RAW and highlights the public participation process and timeline. The beginning and ending dates of the 30-day public comment period will be indicated on the fact sheet with a mailing address where to send comments. Notification of the public comment period will be sent to the *Lompoc Record* and *Santa Maria Times*. The 30-day public comment period begins once the notice of availability is published.

Copies of the Draft Final RAW will be made available for review at four information repositories: the Lompoc Public Library, Public Document Section, 501 E. North Avenue, Lompoc, California; Vandenberg AFB Library, Public Documents Section, 100 Community Loop, Building 10343, Vandenberg AFB, California; the Department of Toxic Substances Control, Office of Military Facilities, 5796 Corporate Avenue, Cypress, California 90630, and the Regional Water Quality Control Board, 895 Aerovista Place, Suite 101, San Luis Obispo, California 93401-7906 The Point of Contact for public comments will be Mr. Ron MacLelland of the IRP Community Relations, Public Participation Specialist, 806 13th Street, Suite 116, Vandenberg AFB, California.

A mailing list will be compiled to include public agencies and members of the CAB. Other addresses will be obtained from the CIP. Public agencies notified will include the DTSC and the RWQCB. Persons requesting copies of the Draft Final RAW or California Environmental Quality Act (CEQA) document may obtain them upon request.

In accordance with the CEQA requirements, the DTSC will prepare an assessment of potential environmental impacts that may be caused during the removal action. The CEQA document will be made available to the public at the same information repositories as the RAW.

Comments received on the Draft RAW will be integrated into the Final RAW. Responses to the comments will be in letter format and will be included as an appendix in the Final RAW.

10.0 REFERENCES

Air Force Center for Environmental Excellence (AFCEE)

2004 *Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents. Final.* Prepared for Air Force Center for Environmental Excellence, Brooks City-Base, Texas; Naval Facilities Engineering Service Center, Port Hueneme, California; Environmental Security Technology Certification Program, Arlington, Virginia. Prepared by The Parsons Corporation. August.

ARCADIS

2003 Interim Demonstration Scale Test Report, In-situ Substrate Addition to Create Reactive Zones for Treatment of Chlorinated Aliphatic Hydrocarbons: Vandenberg AFB Prepared for 30 CES/CEV, Vandenberg Air Force Base. October.

Battelle Corporation (Battelle)

1986 *Installation Restoration Program Phase II Confirmation/Quantification Survey Technical Operations Plan for Vandenberg Air Force Base, California.*

Blake, Thomas F.

1998 *UBCSEIS, A Computer Program for the Estimation of Uniform Building Code Coefficients Using 3-D Fault Sources.*

Blake, Thomas F.

1999 *EQSEARCH, A Computer Program for the Estimation of peak Horizontal Acceleration from California Historical Earthquake Records.*

California Department of Conservation, Division of Mines and Geology (CDMG)

1972, revised 1997, updated 1999, 2003 *Special Publication No. 42, Alquist-Priolo Earthquake Fault Zoning Act.*

California Department of Toxic Substances Control (DTSC)

1995 Department of Toxic Substances Control Remedial Action Plan (RAP) Policy. California Environmental Protection Agency.

California Division of Mines and Geology (CDMG)

2000 *Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Southern Region.*

California, State of

1989 *Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup and Underground Tank Closure.*

Christopher, S.

1997 *Survey for Sensitive Species of Amphibians and Reptiles at Ten IRP Sites, Vandenberg AFB, California.*

Clark, D.G., D.B. Slemmons, S.J. Caskey, and D.M. dePolo

1994 *Seismotechtonic Framework of Coastal Central California.* Geological Society of America Special Paper No 292.

Coleman, D.M.

2004 Memorandum regarding the review of cultural resources for IRP Remedial Action 32/35 by Dina M Coleman, CEVPC, Cultural Resources. Notes from site Visits conducted 29 July 2004 and 2 August 2004 Memorandum dated 2 August

Costa, J.E. and V.R. Baker

1981 *Surficial Geology, Building With the Earth.* John Wiley & Sons, Canada.

Dames and Moore

1993 Request for Determination of Eligibility, Atlas 576-G, Vandenberg Air Force Base, California.

Dibblee, T.W., Jr

1989 *Geologic Map of the Casmalia and Orcutt Quadrangles,* Santa Barbara County, California. Dibblee Geologic Foundation, Santa Barbara, California.

Garvey, Timothy, and Ewelina Mutkowska

n.d. *Substrate Selection Methodology for Enhanced In-Situ Bioremediation of Chlorinated Ethenes.* TN & Associates, Inc., Ventura, CA.

Geoprobe Systems

2002 *Geoprobe 0.5-in. x 1.4-in OD and 0.75-in. x 1.4-in. OD Prepacked Screen Monitoring Wells, Standard Operating Procedure.* Technical Bulletin No 962000. June.

International Conference of Building Officials (ICBO)

1998 *Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada.*

Interstate Technology and Regulatory Cooperation Work Group

2001 Technical/Regulatory Guidelines, Phytotechnology Technical and Regulatory Guidance Document. April.

Jacobs Engineering Group, Inc (JEG)

1992 Installation Restoration Program (IRP), Draft Site Investigation, Site 32 (Missile Silo 576-D), Vandenberg Air Force Base, California.

Jacobs Engineering Group, Inc. (JEG)

1993a *Installation Restoration Program Remedial Investigation/Feasibility Study Work Plan for Operable Units 1, 2, 3B, 4 and 5, Vandenberg Air Force Base, California.* Prepared for 703 CES/CEVR Installation Restoration Program, Vandenberg AFB, California, 93437, and Headquarters Air Force Space Command (HQ AFSPACECOM), Peterson Air Force Base, Colorado.

Jacobs Engineering Group, Inc. (JEG)

1993b *Installation Restoration Program Remedial Investigation/Feasibility Study Health and Safety Plan for Operable Units 1, 2, 3B, 4, and 5.* Prepared for 730 CES/CEVR, Installation Restoration Program, Vandenberg Air Force Base, California, and Headquarters Air Force Space Command (HQ AFSPACECOM), Peterson Air Force Base, Colorado.

Jennings, Charles W.
1994 *Fault Activity Map of California and Adjacent Areas,* California Department of Conservation, Division of Mines and Geology California Geologic Data Map Series Map No. 06.

Moore, S.
1998 Personal communication with Mr. Moore, 576 FLTS, Vandenberg Air Force Base, California. 3 February

Reynolds, Smith and Hill, Inc. (Reynolds)
1985 *Installation Restoration Program, Phase I. Records Search, Vandenberg Air Force Base, California.* Prepared for HQ SAC/DEPV, Offutt Air Force Base, Nebraska. With the assistance of United States Air Force, HQ AFESC/DEVP, Tyndall Air Force Base, Florida. Submitted by Reynolds, Smith and Hills, Inc., Jacksonville, Florida, and Environmental Science and Engineering, Inc., Gainesville, Florida.

Science Applications International Corporation (SAIC)
1990 *Installation and Restoration Program (IRP), Stage 1 - Site Characterization for Vandenberg Air Force Base, California.* Prepared for Headquarters Strategic Air Command - Environmental Compliance Division (Offutt Air Force Base, Texas). Prepared by SAIC, Golden, Colorado. April

Shipman, G.E.
1972 *Soil Survey of the Northern Santa Barbara Area, California.* United States Department of Agriculture, Soil Conservation Services, in cooperation with University of California Agricultural Experiment Station.

State Water Resources Control Board (SWRCB)
1994 *Application of State Water Board Resolution 68-16 to Cleanup of Contaminated Groundwater.* February.

Tetra Tech, Inc. (Tetra Tech)
1999 *Tetra Tech Corporate Health and Safety Manual.*

U.S. Air Force
1987 Mineral Resource Management Plan (Final), Potential Exploration, Development, and Production of the Oil and Gas. Vandenberg AFB, California

U.S. Air Force
1991 *Handbook to Support the Installation Restoration Program (IRP), Statement of Work, Volume I- Remedial Investigation/Feasibility Study (RI/FS).*

U.S. Air Force
1993 *1958 to 1952 Vandenberg Air Force Base Launch Summary.* Vandenberg Air Force Base.

U.S. Air Force
1995 Memorandum of Agreement for Specific Human Health Risk Assessment Issues Among Vandenberg Air Force Base, California Department of Toxic Substances Control, and California Regional Water Quality Control Board, Central Coast Region. 2 June

U.S. Air Force
1996 *Waste Management Plan Addendum*. 730 CES/CEVR, IRP, Vandenberg Air Force Base, California, and Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc.

U.S. Air Force
1998 *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*. Headquarters, Air Force Center for Environmental Excellence (AFCEE), Technology Transfer Division, Brooks Air Force Base, Texas. November.

U.S. Air Force
1999a *Draft Remedial Investigation Report, Site 32-Missle Silo 576D and Site 35-Missle Silo 576G, Operable Unit 4 Remedial Investigation/Feasibility Study*. 30 CES/CEV Installation Restoration Program, Vandenberg Air Force Base, California, 93437, Headquarters Air Force Space Command, Peterson Air Force Base, Colorado Prepared by Tetra Tech, Inc.

U.S. Air Force
1999b *Management Action Plan, Vandenberg Air Force Base*

U.S. Air Force
2000a *Solid Waste Management Plan, 30 SW Plan 32-7042*. Vandenberg Air Force Base. 30 June.

U.S. Air Force
2000b *Wastewater Management Plan, 30 SW Plan 32-7041-A*. Vandenberg Air Force Base. 31 August.

U.S. Air Force
2001 Site 35 Interim Removal Action Closure Report, Operable Unit 4, Vandenberg Air Force Base, California. October 17.

U.S. Air Force
2002 *Hazardous Waste Management Plan, 30 SW Plan 32-7043-A*. Vandenberg Air Force Base. 15 April.

U.S. Air Force
2003 *Basewide Sampling and Analysis Plan. Final*. Prepared for 30 CES/CEV, Installation Restoration Program, Vandenberg Air Force Base, California, and Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc. September.

U.S. Air Force
2004a *Draft Final Remedial Investigation Report, Site 32-Missle Silo 576D and Site 35-Missle Silo 576G, Operable Unit 4 Remedial Investigation/Feasibility Study*. 30 CES/CEV Installation Restoration Program, Vandenberg Air Force Base, California, 93437, Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc. June.

U.S. Air Force
2004b *Basewide Groundwater Monitoring Program Annual Report, Vandenberg Air Force Base, California. Draft.* Prepared for Department of the Air Force 30 CES/CEVR, 806 13th Street, Suite 116, Vandenberg Air Force Base, California and Department of the Air Force, Air Force Center for Environmental Excellence, DERA Restoration Division, 3300 Sidney Brooks, Brooks City-Base, Texas. Prepared by Tetra Tech, Inc. November.

U.S. Air Force
2005 *Waste Management Plan Addendum. Final.* 730 CES/CEVR, Installation Restoration Program, Vandenberg Air Force Base, California, and Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc. February.

U.S. Census Bureau
2000 Profile of General Demographic Characteristics. 2000 Census of Population and Housing, California. Available online at http://www.census.gov/prod/cen2000/dp1/2kh06.pdf

U.S. Environmental Protection Agency (U.S. EPA)
1988 *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final.* Office of Emergency and Remedial Response, Washington, DC. December. EPA-540/6-89/004

U.S. Environmental Protection Agency
1993 *Methods for Chemical Analysis of Water and Wastes.*

U.S. Environmental Protection Agency (U.S. EPA)
1996 *Test Methods for Evaluating Solid Waste. Physical/Chemical Methods, SW-846.* 3rd Edition Updates.

U.S. Environmental Protection Agency (U.S. EPA)
2002 U.S. EPA Office of Underground Storage Tanks (OUST). MNA Frequently Asked Question (FAQ) 8. What is a reasonable timeframe for remediation? Available online at http://www.epa.gov/swerustl/oswermna/mnafaq8.htm

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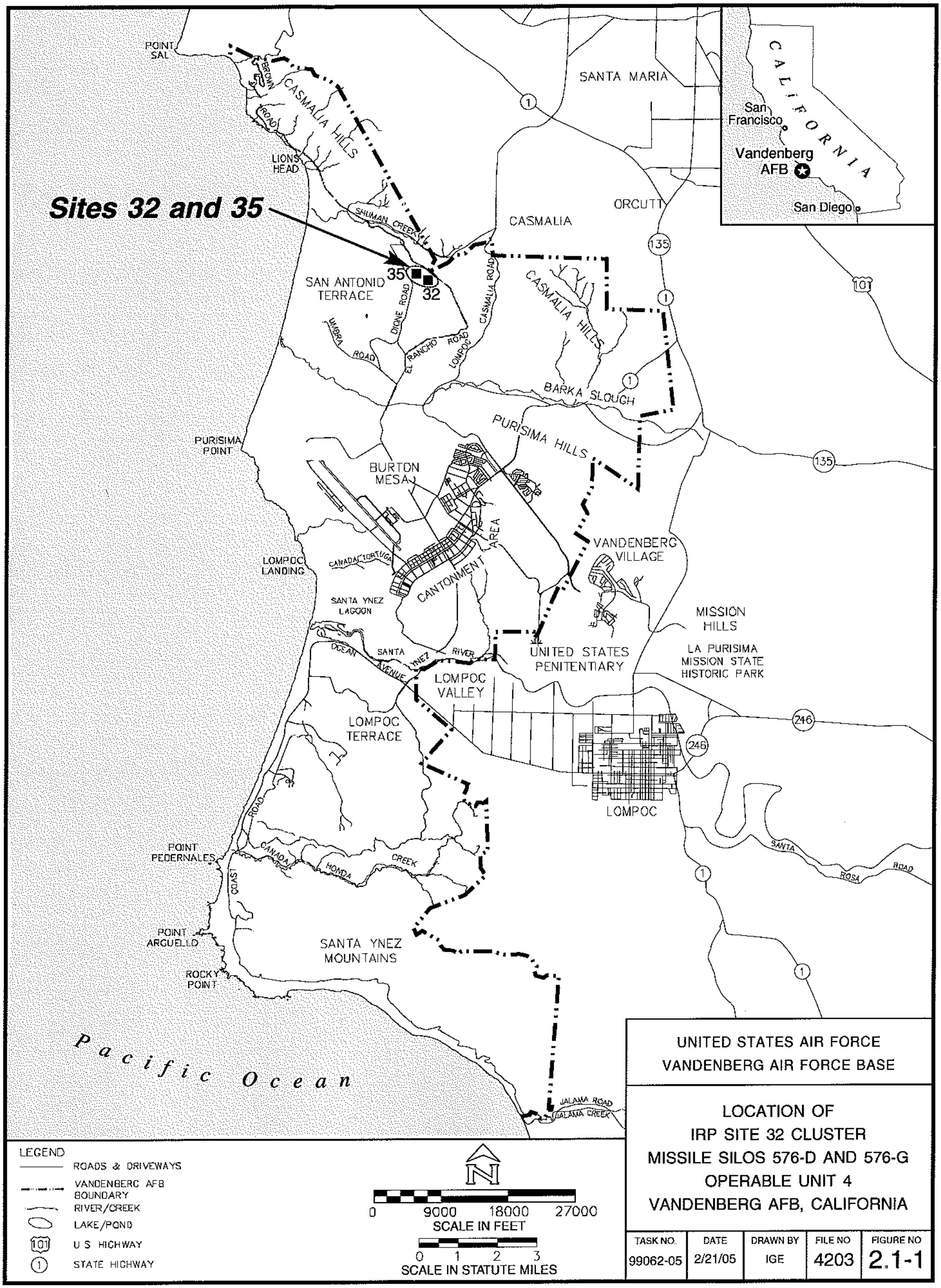
11.0 ACRONYMS AND ABBREVIATIONS

30th CES/CEVPC	30th Civil Engineer Squadron Environmental Flight, Cultural Resources Section
AFB	Air Force Base
APCL	Applied Physics & Chemistry Laboratories
ARAR	applicable or relevant and appropriate requirement
Battelle	Battelle Corporation
BGMP	basewide groundwater monitoring program
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
BTV	background threshold value
CAB	Community Advisory Board
CCR	California Code of Regulations
CEA	competing electron acceptor
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIP	Community Involvement Plan
CSM	Conceptual Site Model
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DO	dissolved oxygen
DTSC	Department of Toxic Substances Control (*Cal EPA*)
ET	evapotranspiration
F	Fahrenheit
gpm	gallons per minute
HI	Hazard Index
HQ	hazard quotient
HSA	hollow stem auger
IDW	investigation-derived waste
IRA	interim removal action
IRP	Installation Restoration Program
IRZ	in-situ reactive zone
IWTP	Industrial Wastewater Treatment Plant
JEG	Jacobs Engineering Group
LOX	liquid oxygen
MCL	maximum contaminant level
µg/L	micrograms per liter

mg/L	milligrams per liter
MNA	monitored natural attenuation
MOA	memorandum of agreement
msl	mean sea level
MT3D	Modular Three Dimensional Transport Model
NAD	North American Datum
NAVD	North American Vertical Datum
NCP	National Contingency Plan
O&M	operations and maintenance
ORP	oxidation - reduction potential
PCB	polychlorinated biphenyl
PCE	perchloroethene; tetrachloroethene
PRB	permeable reactive barrier
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RA-C	remedial action construction
RAW	remedial action work plan
RCRA	Resource Conservation and Recovery Act
Reynolds	Reynolds, Smith and Hill, Inc.
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RT3D	Reactive Transport Simulation Software Model
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SWRCB	State Water Resources Control Board
TCA	trichloroethane
TCE	trichloroethene
Tetra Tech	Tetra Tech, Inc.
TOC	total organic carbon
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound
Vironex	Vironex Environmental Field Services

FIGURES



UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

LOCATION OF
IRP SITE 32 CLUSTER
MISSILE SILOS 576-D AND 576-G
OPERABLE UNIT 4
VANDENBERG AFB, CALIFORNIA

TASK NO.	DATE	DRAWN BY	FILE NO	FIGURE NO
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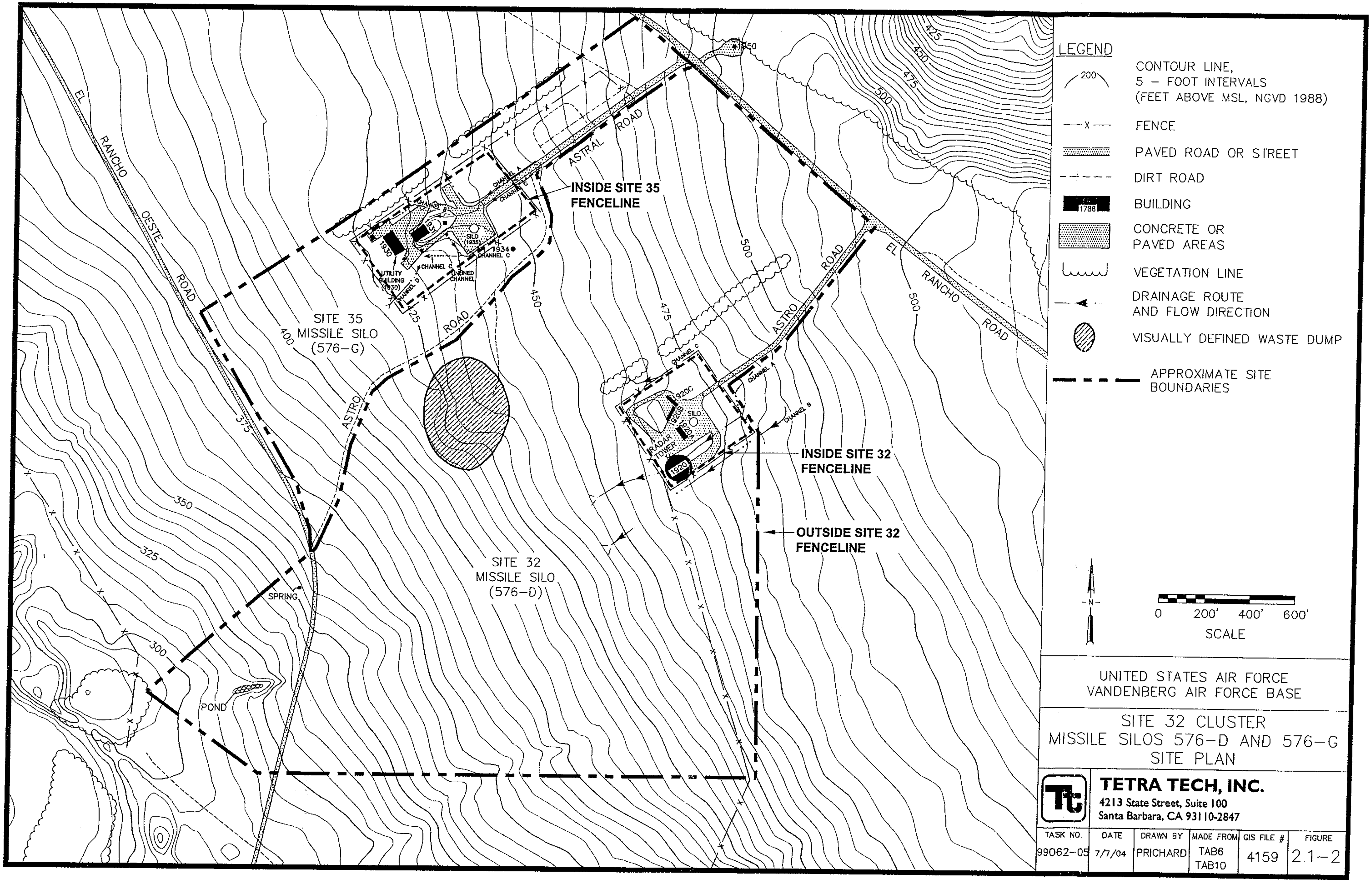
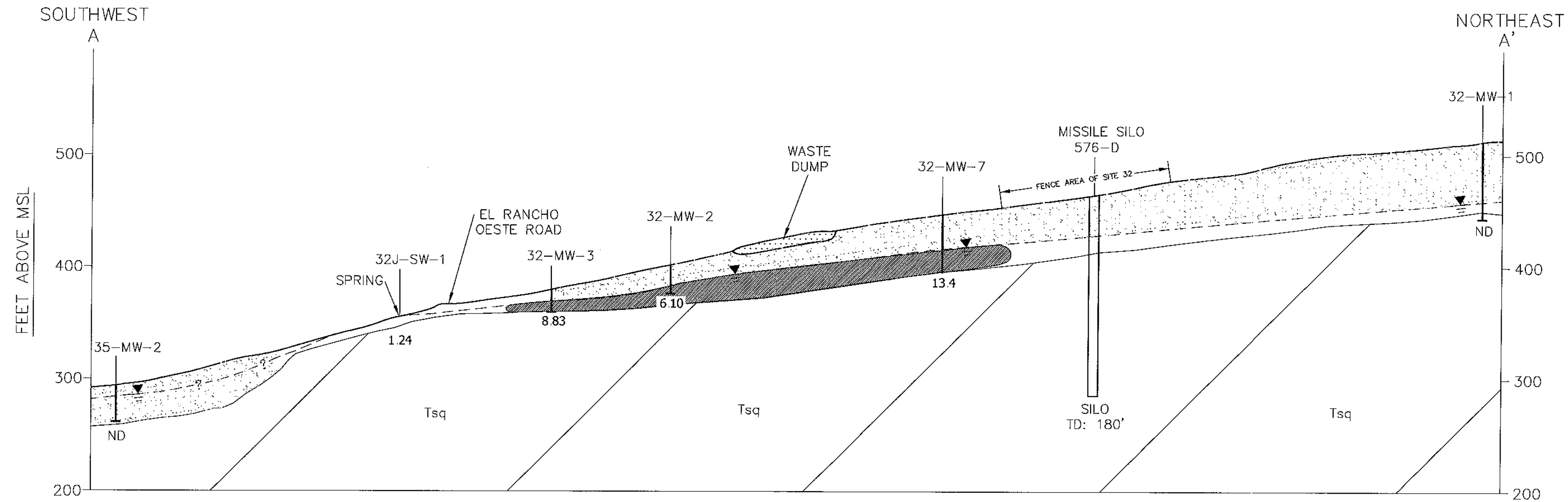


LEGEND
CONTOUR LINE, 5 - FOOT INTERVALS (FEET ABOVE MSL, NGVD 1988)
FENCE
PAVED ROAD OR STREET
DIRT ROAD
BUILDING
CONCRETE OR PAVED AREAS
VEGETATION LINE
DRAINAGE ROUTE AND FLOW DIRECTION
VISUALLY DEFINED WASTE DUMP
APPROXIMATE SITE BOUNDARIES
EL RANCHO OESTE ROAD
ASTRAL ROAD
ASTRO ROAD
EL RANCHO ROAD
INSIDE SITE 35 FENCELINE
SITE 35 MISSILE SILO (576-G)
INSIDE SITE 32 FENCELINE
OUTSIDE SITE 32 FENCELINE
SITE 32 MISSILE SILO (576-D)
UTILITY BUILDING (1930)
SILO (1935)
RADAR TOWER
SPRING
POND
0 200' 400' 600'
SCALE
UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE
SITE 32 CLUSTER
MISSILE SILOS 576-D AND 576-G
SITE PLAN
TETRA TECH, INC.
4213 State Street, Suite 100
Santa Barbara, CA 93110-2847
TASK NO. 99062-05
DATE 7/7/04
DRAWN BY PRICHARD
MADE FROM TAB6 TAB10
GIS FILE # 4159
FIGURE 2.1-2



LEGEND

WASTE, EXCAVATED BEDROCK

ORCUTT FORMATION

Tsq SISQUOC FORMATION ASSUMED BEDDING PLANE DIP

1.24 WINTER 04 TCE CONCENTRATION IN μg/L

ND NOT DETECTED

ELEVATIONS ADJUSTED TO 1988 NAVD

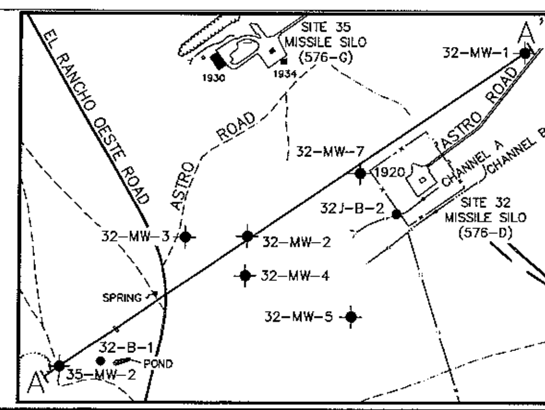
35J-B-1 SOIL BORING

32-MW-3 GROUNDWATER MONITORING WELL TOTAL BORING DEPTH INDICATED

GROUNDWATER DASHED WHERE INFERRED

LITHOLOGIC CONTACT DASHED WHERE INFERRED

GROUNDWATER TCE >5 μg/L



0' 100' 200' 300'
HORIZONTAL SCALE IN FEET

0' 50' 100'
VERTICAL SCALE IN FEET
3X VERTICAL EXAGGERATION

UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

SITE 32
MISSILE SILO 576-D
GEOLOGIC CROSS SECTION (A-A')

TETRA TECH, INC.
4213 State Street, Suite 100
Santa Barbara, CA 93110-2847

TASK NO	DATE	DRAWN BY	MADE FROM	ACAD FILE #	FIGURE NO.
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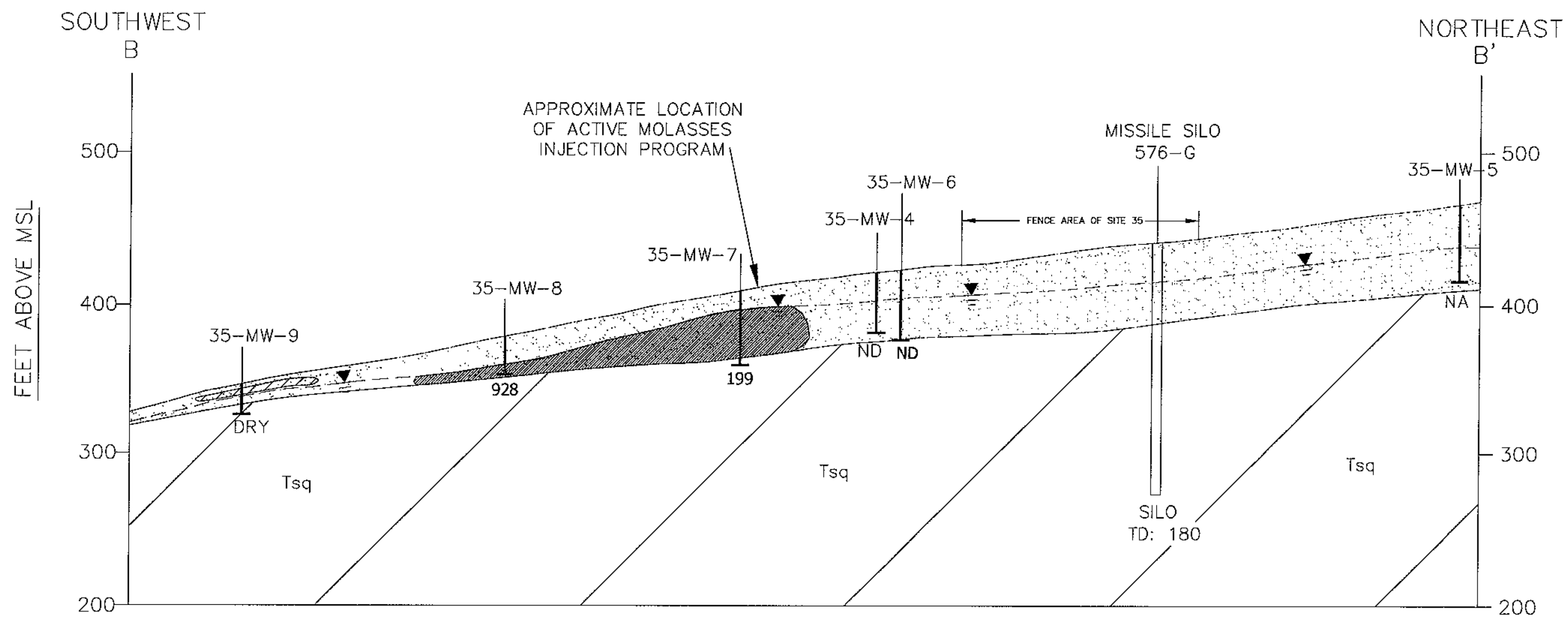


LEGEND

ORCUTT FORMATION

POORLY GRADED SAND

CLAY LENSES

SISQUOC FORMATION

Tsq ASSUMED BEDDING PLANE DIP

35-MW-9 GROUNDWATER MONITORING WELL

928 WINTER 04 TCE CONCENTRATION IN $\mu g/L$

ND NOT DETECTED

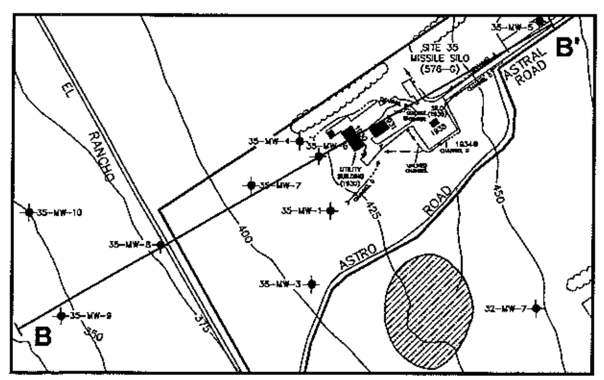
NA NOT ANALYZED

GROUNDWATER TABLE

LITHOLOGIC CONTACT

GROUNDWATER TCE CONCENTRATION >5 $\mu g/L$

ELEVATIONS ADJUSTED TO 1988 NAVD



0' 100' 200' 300'
HORIZONTAL SCALE IN FEET

0' 50' 100'
VERTICAL SCALE IN FEET
3X VERTICAL EXAGGERATION

UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

SITE 32 CLUSTER
MISSILE SILOS 576-D AND 576-G
GEOLOGIC CROSS SECTION (B-B')

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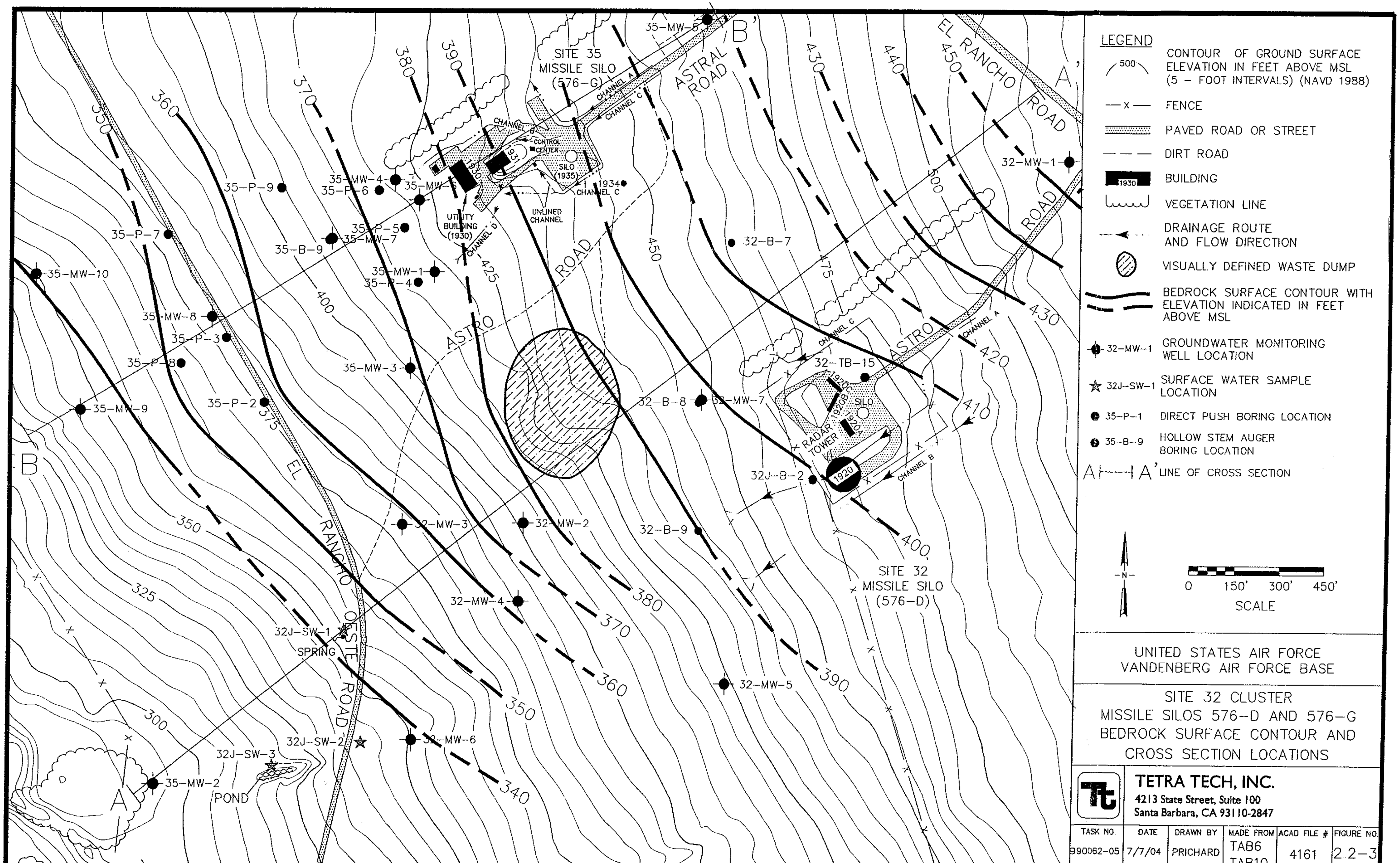

UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

SITE 32 CLUSTER
MISSILE SILOS 576–D AND 576–G
BEDROCK SURFACE CONTOUR AND
CROSS SECTION LOCATIONS

TETRA TECH, INC.
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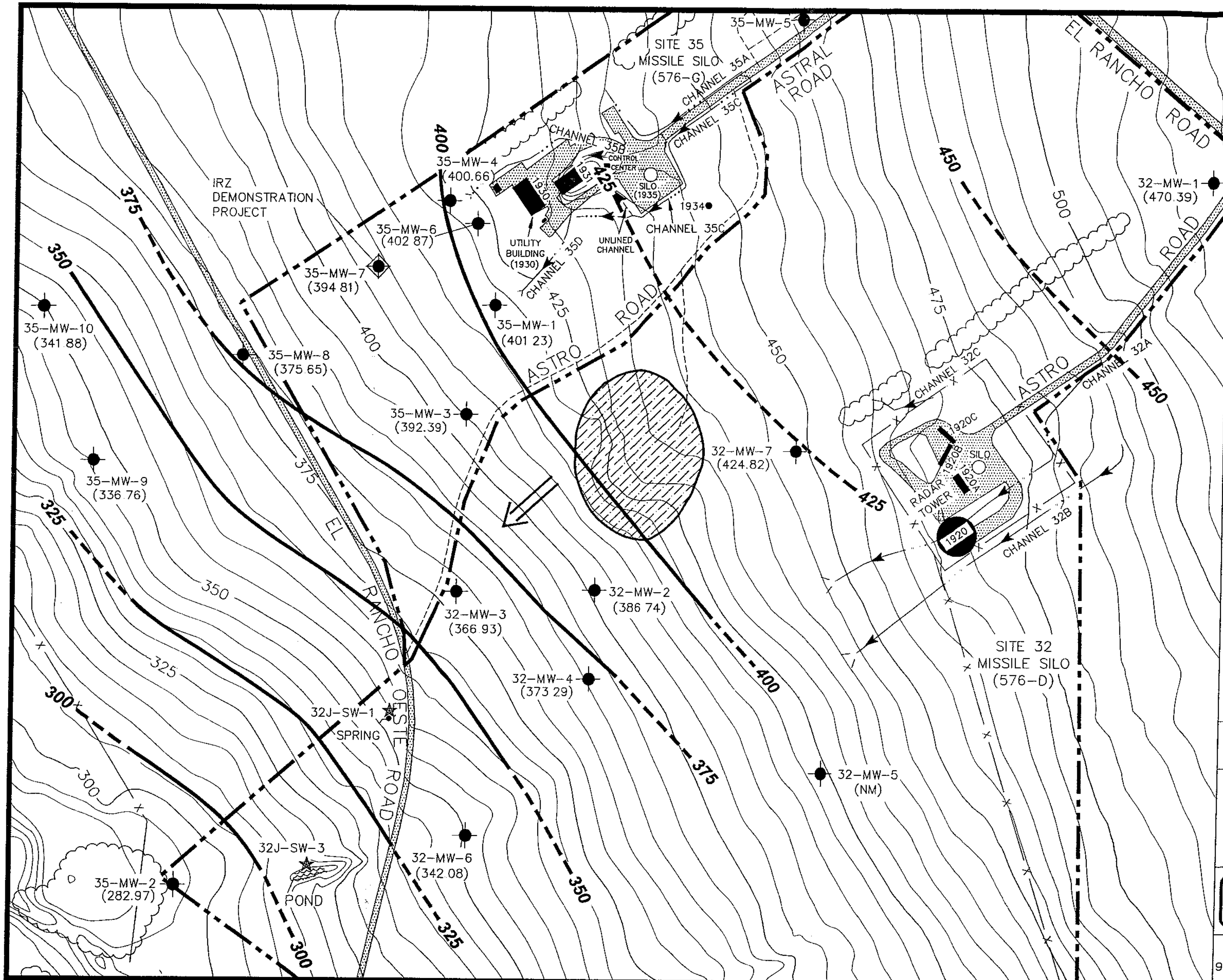
Santa Barbara, CA 93110-2847

TASK NO.	DATE	DRAWN BY	MADE FROM	ACAD FILE #	FIGURE NO.
990062–05	7/7/04	PRICHARD	TAB6 TAB10	4161	2.2–3



LEGEND

- CONTOUR OF GROUND SURFACE ELEVATION IN FEET ABOVE MSL (5 - FOOT INTERVALS) (NAVD 1988)
- FENCE
- PAVED ROAD OR STREET
- DIRT ROAD
- BUILDING
- CONCRETE OR PAVED AREAS
- VEGETATION LINE
- UNLINED DRAINAGE ROUTE AND FLOW DIRECTION
- SITE BOUNDARY
- VISUALLY DEFINED WASTE DISPOSAL AREA
- 32-MW-1 (470.39) GROUNDWATER MONITORING WELL WITH GROUNDWATER ELEVATION
- 32J-SW-1 SURFACE WATER SAMPLE LOCATION
- 425 — 425 GROUNDWATER ELEVATION CONTOUR APPROXIMATED BY LINEAR INTERPOLATION (DASHED WHERE INFERRED)
- INFERRED GROUNDWATER FLOW DIRECTION

NOTE: GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL AS MEASURED IN FEBRUARY 2004

N

0 150' 300' 450'
SCALE

UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

SITE 32 CLUSTER
MISSILE SILOS 576-D AND 576-G
SITE PLAN AND
GROUNDWATER CONTOURS
WINTER 2004

TETRA TECH, INC.
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Santa Barbara, CA 93110-2847

TASK NO.	DATE	DRAWN BY	MADE FROM	ACAD FILE #	Figure
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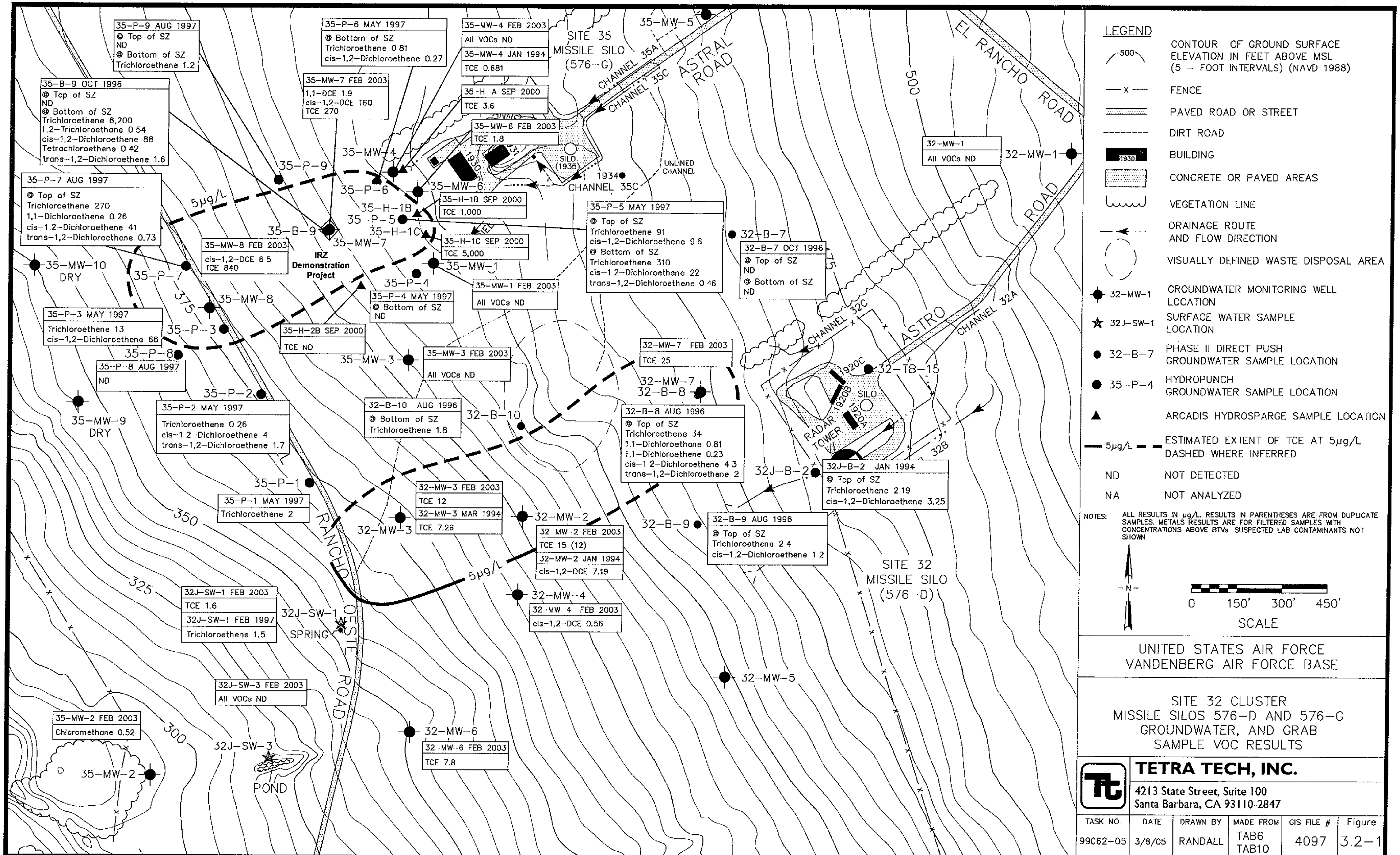
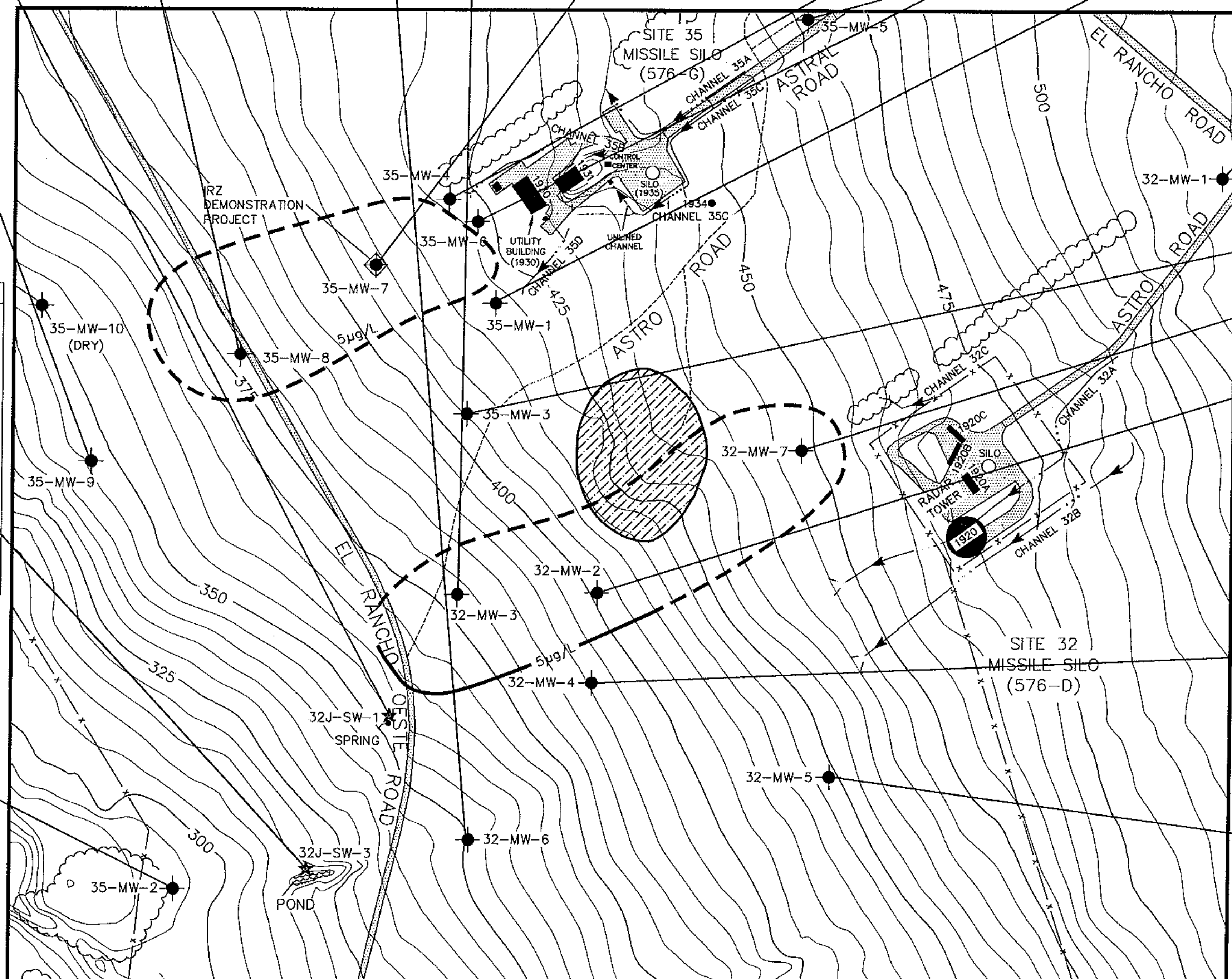

35-P-9 AUG 1997
Top of SZ
ND
Bottom of SZ
Trichloroethene 1.2
35-P-6 MAY 1997
Bottom of SZ
Trichloroethene 0.81
cis-1,2-Dichloroethene 0.27
35-MW-4 FEB 2003
All VOCs ND
35-MW-4 JAN 1994
TCE 0.681
SITE 35
MISSILE SILO
(576-G)
35-MW-5
CHANNEL 35A
CHANNEL 35C
ASTRAL ROAD
EL RANCHO ROAD
500
35-B-9 OCT 1996
Top of SZ
ND
Bottom of SZ
Trichloroethene 6,200
1,2-Trichloroethane 0.54
cis-1,2-Dichloroethene 88
Tetrachloroethene 0.42
trans-1,2-Dichloroethene 1.6
35-MW-7 FEB 2003
1,1-DCE 1.9
cis-1,2-DCE 160
TCE 270
35-H-A SEP 2000
TCE 3.6
35-MW-6 FEB 2003
TCE 1.8
SILO (1935)
UNLINED CHANNEL
1934
CHANNEL 35C
32-MW-1
All VOCs ND
35-P-9
35-MW-4
35-P-7 AUG 1997
Top of SZ
Trichloroethene 270
1,1-Dichloroethene 0.26
cis-1,2-Dichloroethene 41
trans-1,2-Dichloroethene 0.73
5µg/L
35-P-6
35-MW-6
35-H-1B SEP 2000
TCE 1,000
35-H-1B
35-P-5
35-H-1C
35-B-9
35-MW-7
35-H-1C SEP 2000
TCE 5,000
35-P-5 MAY 1997
Top of SZ
Trichloroethene 91
cis-1,2-Dichloroethene 9.6
Bottom of SZ
Trichloroethene 310
cis-1,2-Dichloroethene 22
trans-1,2-Dichloroethene 0.46
32-B-7
32-B-7 OCT 1996
Top of SZ
ND
Bottom of SZ
ND
ROAD
35-MW-10
DRY
35-MW-8 FEB 2003
cis-1,2-DCE 6.5
TCE 840
IRZ Demonstration Project
35-MW-1
35-P-7
35-P-4
35-MW-1 FEB 2003
All VOCs ND
375
35-MW-8
35-P-4 MAY 1997
Bottom of SZ
ND
35-P-3 MAY 1997
Trichloroethene 13
cis-1,2-Dichloroethene 66
35-P-3
35-H-2B SEP 2000
TCE ND
CHANNEL 32C
ASTRO
CHANNEL 32A
35-P-8
35-P-8 AUG 1997
ND
35-MW-3
35-MW-3 FEB 2003
All VOCs ND
32-MW-7 FEB 2003
TCE 25
1920C
32-TB-15
35-MW-9
DRY
35-P-2
35-P-2 MAY 1997
Trichloroethene 0.26
cis-1,2-Dichloroethene 4
trans-1,2-Dichloroethene 1.7
32-B-10 AUG 1996
Bottom of SZ
Trichloroethene 1.8
32-B-10
32-MW-7
32-B-8
32-B-8 AUG 1996
Top of SZ
Trichloroethene 34
1,1-Dichloroethane 0.81
1,1-Dichloroethene 0.23
cis-1,2-Dichloroethene 4.3
trans-1,2-Dichloroethene 2
1920B
SILO
1920A
RADAR TOWER
32B
32J-B-2
32J-B-2 JAN 1994
Top of SZ
Trichloroethene 2.19
cis-1,2-Dichloroethene 3.25
35-P-1
35-P-1 MAY 1997
Trichloroethene 2
32-MW-3 FEB 2003
TCE 12
32-MW-3 MAR 1994
TCE 7.26
32-MW-3
32-MW-2
32-MW-2 FEB 2003
TCE 15 (12)
32-MW-2 JAN 1994
cis-1,2-DCE 7.19
32-B-9
32-B-9 AUG 1996
Top of SZ
Trichloroethene 2.4
cis-1,2-Dichloroethene 1.2
350
RANCHO
5µg/L
SITE 32
MISSILE SILO
(576-D)
325
32J-SW-1 FEB 2003
TCE 1.6
32J-SW-1 FEB 1997
Trichloroethene 1.5
32J-SW-1
SPRING
OESTE ROAD
32-MW-4
32-MW-4 FEB 2003
cis-1,2-DCE 0.56
32J-SW-3 FEB 2003
All VOCs ND
32-MW-5
35-MW-2 FEB 2003
Chloromethane 0.52
300
32J-SW-3
32-MW-6
32-MW-6 FEB 2003
TCE 7.8
35-MW-2
POND
LEGEND
500 CONTOUR OF GROUND SURFACE ELEVATION IN FEET ABOVE MSL (5 - FOOT INTERVALS) (NAVD 1988)
FENCE
PAVED ROAD OR STREET
DIRT ROAD
1930 BUILDING
CONCRETE OR PAVED AREAS
VEGETATION LINE
DRAINAGE ROUTE AND FLOW DIRECTION
VISUALLY DEFINED WASTE DISPOSAL AREA
32-MW-1 GROUNDWATER MONITORING WELL LOCATION
32J-SW-1 SURFACE WATER SAMPLE LOCATION
32-B-7 PHASE II DIRECT PUSH GROUNDWATER SAMPLE LOCATION
35-P-4 HYDROPUNCH GROUNDWATER SAMPLE LOCATION
ARCADIS HYDROSPARGE SAMPLE LOCATION
5µg/L ESTIMATED EXTENT OF TCE AT 5µg/L DASHED WHERE INFERRED
ND NOT DETECTED
NA NOT ANALYZED
NOTES: ALL RESULTS IN µg/L. RESULTS IN PARENTHESES ARE FROM DUPLICATE SAMPLES. METALS RESULTS ARE FOR FILTERED SAMPLES WITH CONCENTRATIONS ABOVE BTVs. SUSPECTED LAB CONTAMINANTS NOT SHOWN.
N
0 150' 300' 450'
SCALE
UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE
SITE 32 CLUSTER
MISSILE SILOS 576-D AND 576-G
GROUNDWATER, AND GRAB
SAMPLE VOC RESULTS
TETRA TECH, INC.
4213 State Street, Suite 100
Santa Barbara, CA 93110-2847
TASK NO. 99062-05
DATE 3/8/05
DRAWN BY RANDALL
MADE FROM TAB6 TAB10
GIS FILE # 4097
Figure 3.2-1



32J-SW-1	TCE
Win-94	0.939
Win-97	1.5
Spr-98	NA
Fall-99	2.5
Win-00	2.4
Spr-00	1.8
Sum-00	ND
Fall-00	2.3
Win-01	2.1
Spr-01	NA
Sum-01	2.4
Fall-01	NA
Win-02	3.4
Spr-02	NA
Sum-02	2.5
Fall-02	NA
Win-03	1.6
Spr-03	NA
Sum-03	2.10
Fall-03	NA
Win-04	1.24

35-MW-8	TCE	cis-1,2-DCE	trans-1,2-DCE
Win-94	NA	NA	NA
Win-97	NA	NA	NA
Spr-98	650	ND	ND
Fall-99*	870	5.8	0.56
Win-00	760	9.2	0.92
Spr-00	820	5.9	ND
Sum-00	1,100	ND	ND
Fall-00	1,100	ND	ND
Win-01	680	1	ND
Spr-01	1,000	9.4	ND
Sum-01	830	3.2	ND
Fall-01	870	4.3	ND
Win-02	1,200	7.6	ND
Spr-02	930	6.4	ND
Sum-02	910	3.3	ND
Fall-02	590	4.7	ND
Win-03	840	6.5	ND
Spr-03	999	5.79	ND
Sum-03	636	2.67	ND
Fall-03	NA	NA	NA
Win-04	928	5.34	ND

32-MW-6	TCE
Win-94	NA
Win-97	ND
Spr-98	0.66
Fall-99	ND
Win-00	ND
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	NA
Sum-01	ND
Fall-01	NA
Win-02	ND
Spr-02	NA
Sum-02	ND
Fall-02	NA
Win-03	7.8
Spr-03	NA
Sum-03	ND
Fall-03	NA
Win-04	ND

32-MW-3	TCE
Win-94	7.26
Win-97	6.9
Spr-98	1.4
Fall-99	8.7
Win-00	4.9
Spr-00	2.0
Sum-00	11
Fall-00	12
Win-01	7.8
Spr-01	NA
Sum-01	11
Fall-01	NA
Win-02	15
Spr-02	NA
Sum-02	13
Fall-02	NA
Win-03	12
Spr-03	NA
Sum-03	7.28
Fall-03	NA
Win-04	8.83

35-MW-7	TCE	cis-1,2-DCE	vinyl chloride
Win-94	NA	NA	NA
Win-97	NA	NA	NA
Spr-98	2,900	55	ND
Fall-99*	870	19	ND
Win-00	730	20	ND
Spr-00	710	25	ND
Sum-00	550	ND	ND
Fall-00	780	10	ND
Win-01	480	10	ND
Spr-01	960	18	ND
Sum-01	510	11	ND
Fall-01	640	15	ND
Win-02	830	12	ND
Spr-02	510	12	ND
Sum-02	NA	NA	ND
Fall-02	250	26	ND
Win-03	270	160	ND
Spr-03	321	115	ND
Sum-03	257	50.5	15.0
Fall-03	NA	NA	NA
Win-04	199	48.9	18.8

35-MW-4	TCE
Win-94	0.681
Win-97	1.1
Spr-98	1
Fall-99*	0.88
Win-00	0.8
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	ND
Sum-01	0.74
Fall-01	ND
Win-02	0.69
Spr-02	0.94
Sum-02	NA
Fall-02	ND
Win-03	ND
Spr-03	NA
Sum-03	NA
Fall-03	NA
Win-04	ND

35-MW-6	TCE
Win-94	NA
Win-97	NA
Spr-98	1.1
Fall-99	1.0
Win-00	1.1
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	0.6
Spr-01	ND
Sum-01	ND
Fall-01	ND
Win-02	ND
Spr-02	ND
Sum-02	ND
Fall-02	ND
Win-03	1.8
Spr-03	1.95
Sum-03	ND
Fall-03	NA
Win-04	ND

35-MW-5	Key COCs
Win-94	NA
Win-97	NA
Spr-98	0.56
Fall-99*	ND
Win-00	ND
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	ND
Sum-01	ND
Fall-01	ND
Win-02	ND
Spr-02	NA
Sum-02	NA
Fall-02	NA
Win-03	NA
Spr-03	NA
Sum-03	NA
Fall-03	NA
Win-04	NA

35-MW-1	Key COCs
Win-94	ND
Win-97	ND
Spr-98	ND
Fall-99*	ND
Win-00	ND
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	ND
Sum-01	ND
Fall-01	ND
Win-02**	ND
Spr-02**	NA
Sum-02*	ND
Fall-02	ND
Win-03	ND
Spr-03	NA
Sum-03	ND
Fall-03	NA
Win-04	ND

32-MW-1	TCE
Win-94	ND
Win-97	ND
Spr-98	12
Fall-99	ND
Win-00	ND
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	NA
Sum-01	ND
Fall-01	NA
Win-02	ND
Spr-02	NA
Sum-02	ND
Fall-02	NA
Win-03	ND
Spr-03	NA
Sum-03	ND
Fall-03	NA
Win-04	ND

35-MW-3	TCE
Win-94	ND
Win-97	NA
Spr-98	0.11
Win-00	ND
Spr-00	ND
Fall-00	ND
Win-00	ND
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	ND
Sum-01	ND
Fall-01	ND
Win-02	ND
Spr-02	NA
Sum-02	NA
Fall-02	NA
Win-03	ND
Spr-03	NA
Sum-03	NA
Fall-03	NA
Win-04	ND

35-MW-9	TCE
Win-94	NA
Win-97	NA
Spr-98	ND
Fall-99	ND
Win-00	1.8
Spr-00	ND
Sum-00	ND
Fall-00	DRY
Win-01	DRY
Spr-01	ND
Sum-01	0.61
Fall-01	DRY
Win-02	DRY
Spr-02	NA
Sum-02	NA
Fall-02	NA
Win-03	DRY
Spr-03	NA
Sum-03	DRY
Fall-03	NA
Win-04	DRY

32J-SW-3	Key COCs
Win-94	ND
Win-97	ND
Spr-98	NA
Fall-99	ND
Win-00	ND
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	NA
Sum-01	ND
Fall-01	NA
Win-02	ND
Spr-02	NA
Sum-02	NA
Fall-02	NA
Win-03	ND
Spr-03	NA
Sum-03	DRY
Fall-03	NA
Win-04	ND

35-MW-2	TCE
Win-94	ND
Win-97	NA
Spr-98	ND
Fall-99*	ND
Win-00	0.77
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	NA
Sum-01	ND
Fall-01	NA
Win-02	ND
Spr-02	NA
Sum-02	ND
Fall-02	NA
Win-03	ND
Spr-03	NA
Sum-03	ND
Fall-03	NA
Win-04	ND

32-MW-7	TCE
Win-94	NA
Win-97	ND
Spr-98	68
Fall-99*	44
Win-00	41
Spr-00	38
Sum-00	46
Fall-00	40
Win-01	29
Spr-01	NA
Sum-01	31
Fall-01	NA
Win-02	35
Spr-02	NA
Sum-02	21
Fall-02	NA
Win-03	25
Spr-03	NA
Sum-03	18.2
Fall-03	NA
Win-04	13.4

32-MW-2	TCE
Win-94	1.76
Win-97	4.7
Spr-98	2.1
Fall-99	14
Win-00	10
Spr-00	22
Sum-00	15
Fall-00	14
Win-01	13
Spr-01	NA
Sum-01	17
Fall-01	NA
Win-02	26
Spr-02	NA
Sum-02	11
Fall-02	NA
Win-03	15
Spr-03	NA
Sum-03	8.4
Fall-03	NA
Win-04	6.10

32-MW-5	TCE
Win-94	ND
Win-97	ND
Spr-98	ND
Fall-99*	ND
Win-00	4.4
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	NA
Sum-01	ND
Fall-01	NA
Win-02	ND
Spr-02	NA
Sum-02	NA
Fall-02	NA
Win-03	NA
Spr-03	NA
Sum-03	NA
Fall-03	NA
Win-04	NA

32-MW-4	TCE
Win-94	4.2
Win-97	ND
Spr-98	0.73
Fall-99*	ND
Win-00	1.4
Spr-00	ND
Sum-00	ND
Fall-00	ND
Win-01	ND
Spr-01	NA
Sum-01	ND
Fall-01	NA
Win-02	ND
Spr-02	NA
Sum-02	ND
Fall-02	NA
Win-03	ND
Spr-03	NA
Sum-03	2.76
Fall-03	NA
Win-04	ND

LEGEND

- 500 — CONTOUR OF GROUND SURFACE ELEVATION IN FEET ABOVE MSL (5 - FOOT INTERVALS) (NAVD 1988)
- FENCE
- PAVED ROAD OR STREET
- DIRT ROAD
- 1930 — BUILDING
- CONCRETE OR PAVED AREAS
- VEGETATION LINE
- DRAINAGE ROUTE AND FLOW DIRECTION
- VISUALLY DEFINED WASTE DISPOSAL AREA
- 32-MW-1 — GROUNDWATER MONITORING WELL LOCATION
- 32J-SW-1 — SURFACE WATER SAMPLE LOCATION
- 5µg/L — ESTIMATED EXTENT OF TCE AT 5µg/L DASHED WHERE INFERRED
- NA — NOT ANALYZED
- ND — NOT DETECTED; RESULT IS LESS THAN THE METHOD DETECTION LIMIT
- * — INSTALLED MICROPURGE PUMP
- ** — REMOVED MICROPURGE PUMP RESUME SAMPLING WITH GRUNDFOS PUMP

N

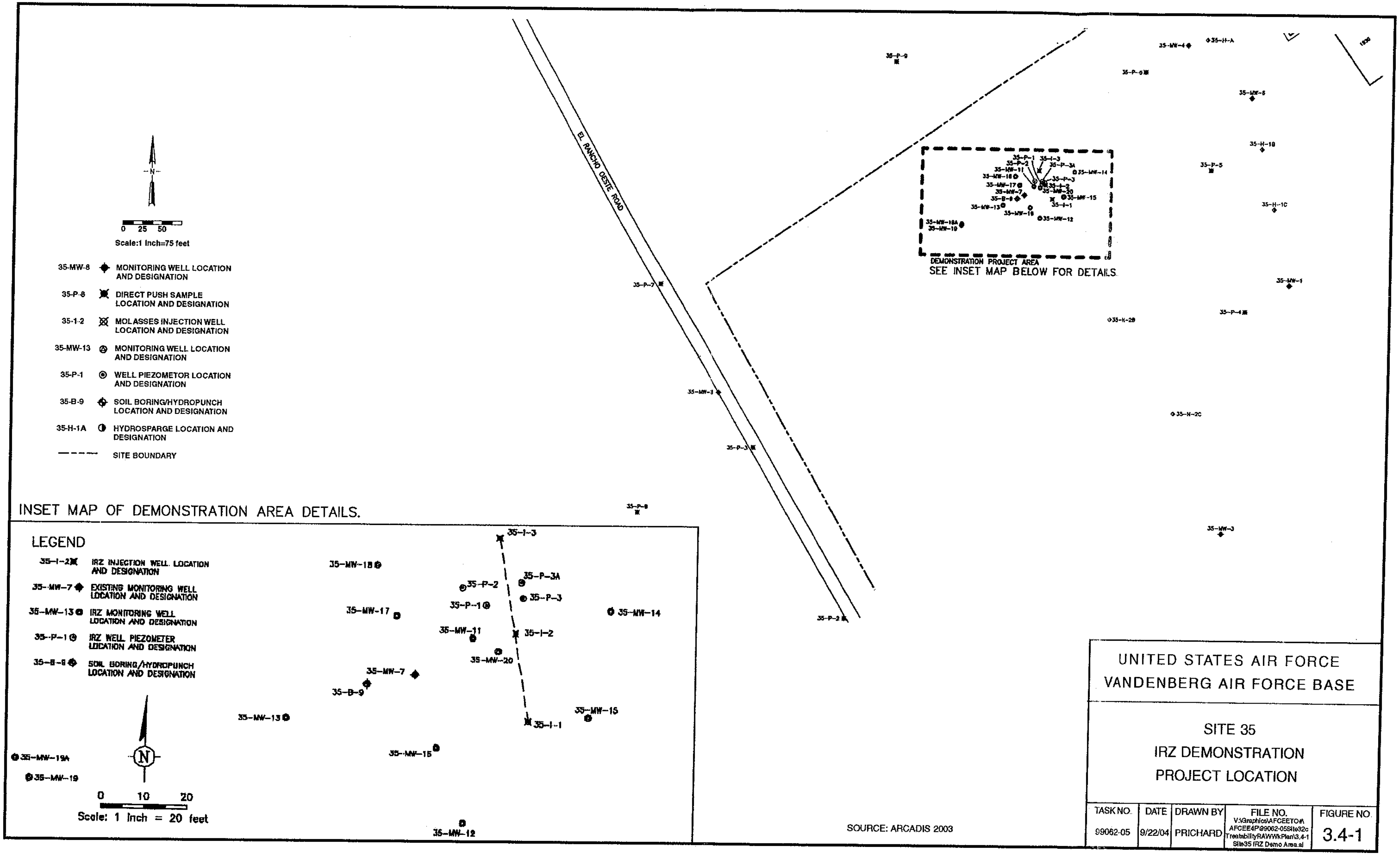
0 200' 400' 600'
SCALE

UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

SITE 32 CLUSTER
MISSILE SILOS 576-D AND 576-G
HISTORICAL ANALYTICAL RESULTS OF
KEY CONTAMINANTS OF CONCERN
WINTER 1994 - WINTER 2004

TETRA TECH, INC.
4213 State Street, Suite 100
Santa Barbara, CA 93110-2847

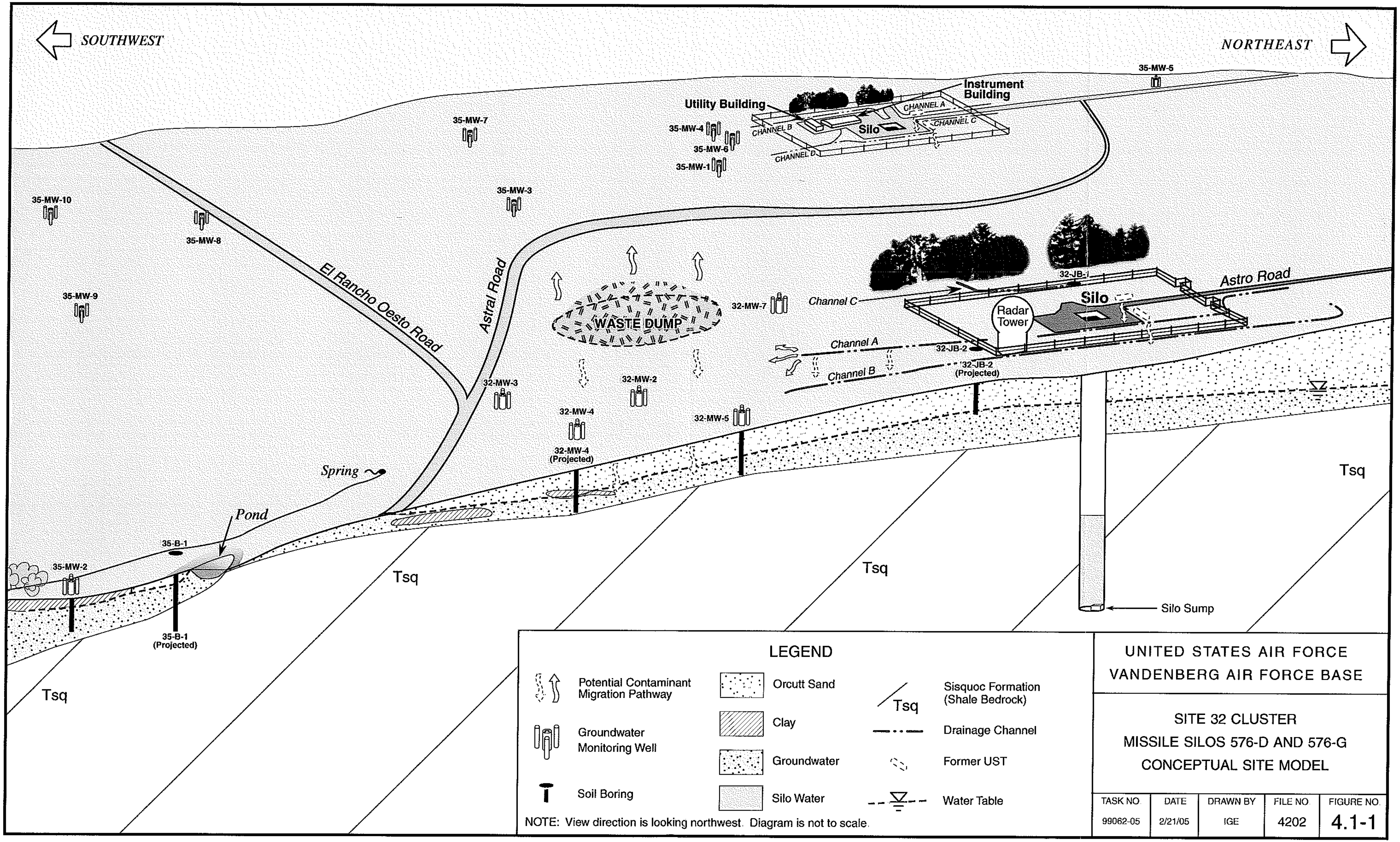
TASK NO.	DATE	DRAWN BY	MADE FROM	ACAD FILE #	Figure
99062-05	3/8/05	RANDALL	TAB6 TAB10	4096	32-2



UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

SITE 35
IRZ DEMONSTRATION
PROJECT LOCATION

TASK NO.	DATE	DRAWN BY	FILE NO.	FIGURE NO.
99062-05	9/22/04	PRICHARD	V:\Graphics\AFCEETO\AFCEE4P\99062-05\Site32c Treatability\RAWWkPlan\3.4-1 Site35 IRZ Demo Area.ai	3.4-1



UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

SITE 32 CLUSTER
MISSILE SILOS 576-D AND 576-G
CONCEPTUAL SITE MODEL

TASK NO.	DATE	DRAWN BY	FILE NO.	FIGURE NO.
99062-05	2/21/05	IGE	4202	4.1-1

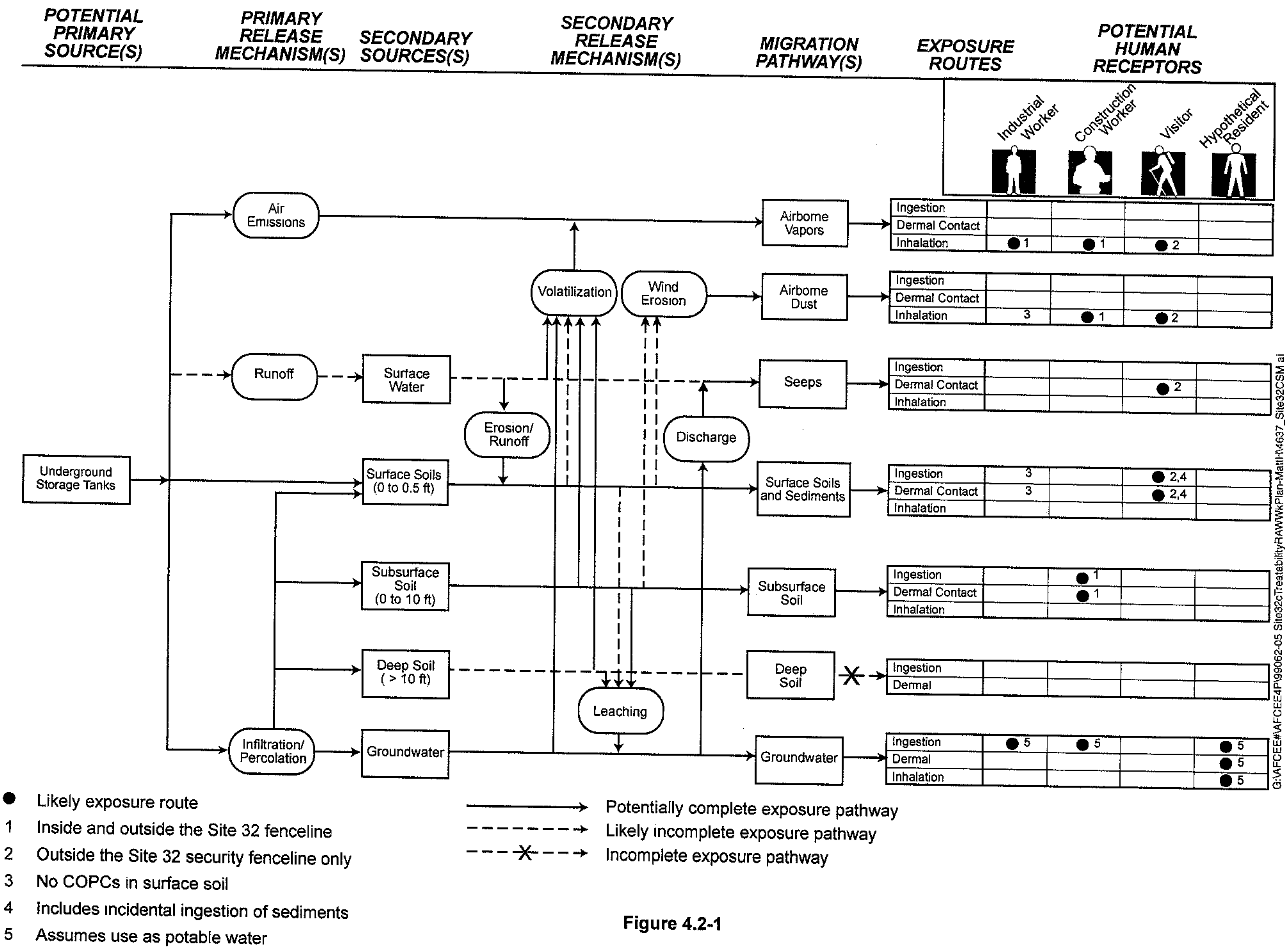


Figure 4.2-1

Conceptual Site Model for Current and Future Human Receptors at Site 32

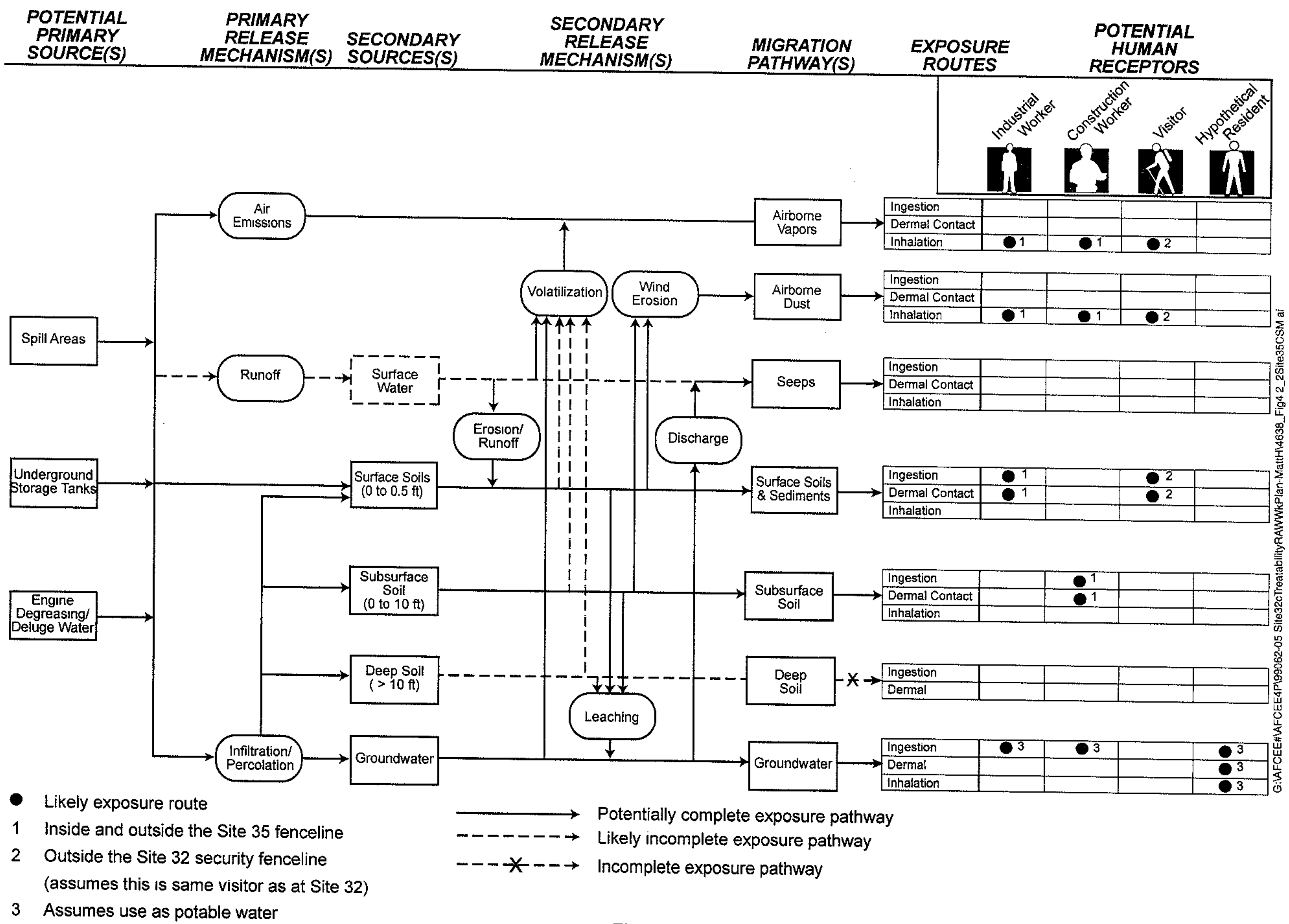


Figure 4.2-2
Conceptual Site Model for Current and Future Human Receptors at Site 35

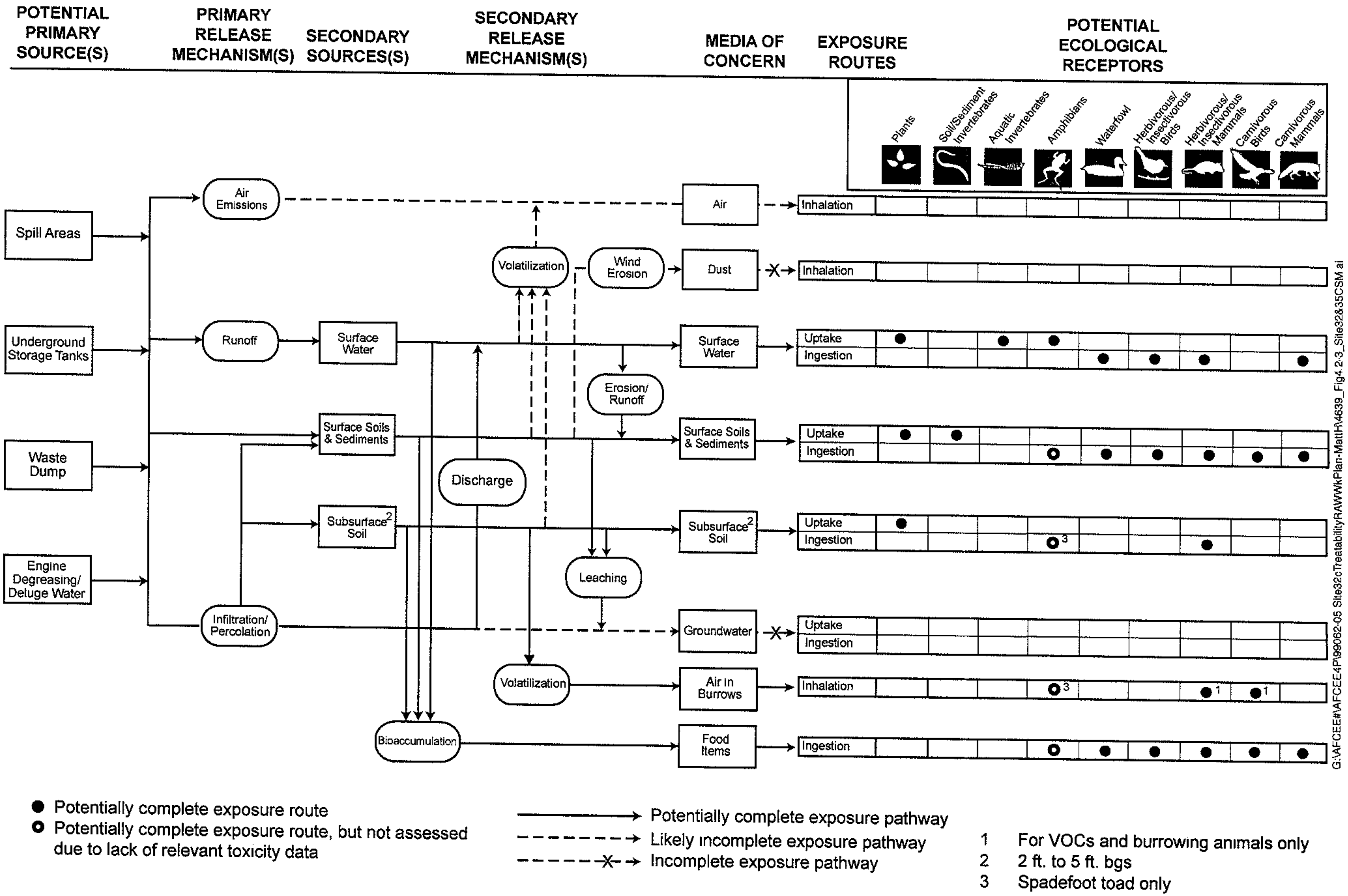
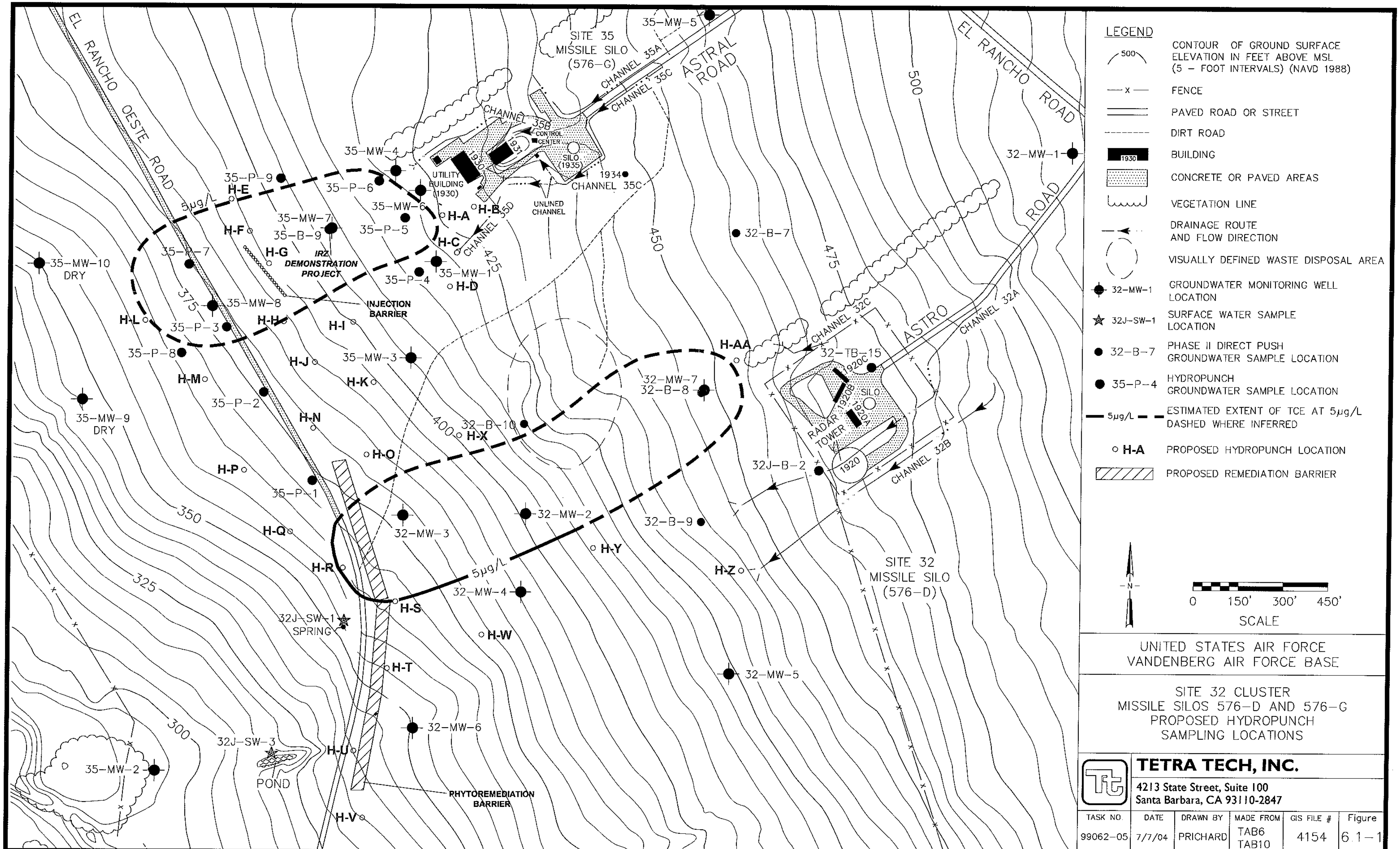


Figure 4.2-3

Conceptual Site Model for Ecological Exposure Pathways at Sites 32 and 35


LEGEND
CONTOUR OF GROUND SURFACE ELEVATION IN FEET ABOVE MSL (5 - FOOT INTERVALS) (NAVD 1988)
FENCE
PAVED ROAD OR STREET
DIRT ROAD
BUILDING
CONCRETE OR PAVED AREAS
VEGETATION LINE
DRAINAGE ROUTE AND FLOW DIRECTION
VISUALLY DEFINED WASTE DISPOSAL AREA
GROUNDWATER MONITORING WELL LOCATION
SURFACE WATER SAMPLE LOCATION
PHASE II DIRECT PUSH GROUNDWATER SAMPLE LOCATION
HYDROPUNCH GROUNDWATER SAMPLE LOCATION
ESTIMATED EXTENT OF TCE AT 5µg/L DASHED WHERE INFERRED
PROPOSED HYDROPUNCH LOCATION
PROPOSED REMEDIATION BARRIER
0 150' 300' 450'
SCALE
EL RANCHO OESTE ROAD
EL RANCHO ROAD
ASTRAL ROAD
ASTRO ROAD
SITE 35 MISSILE SILO (576-G)
SITE 32 MISSILE SILO (576-D)
IRZ DEMONSTRATION PROJECT
INJECTION BARRIER
PHYTOREMEDIATION BARRIER
UTILITY BUILDING (1930)
CONTROL CENTER
SILO (1935)
UNLINED CHANNEL
RADAR TOWER
SPRING
POND
CHANNEL 35A
CHANNEL 35B
CHANNEL 35C
CHANNEL 35D
CHANNEL 32A
CHANNEL 32B
CHANNEL 32C
UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE
SITE 32 CLUSTER
MISSILE SILOS 576-D AND 576-G
PROPOSED HYDROPUNCH
SAMPLING LOCATIONS
TETRA TECH, INC.
4213 State Street, Suite 100
Santa Barbara, CA 93110-2847
TASK NO 99062-05
DATE 7/7/04
DRAWN BY PRICHARD
MADE FROM TAB6 TAB10
GIS FILE # 4154
Figure 6.1-1

TABLES

Table 1.4-1
Schedule for Interim Removal Action at Site 32 Cluster

	Activity	Anticipated Date(s)
1	Vandenberg AFB review of Preliminary Draft RAW	July 20, 2004
2	Receive AFCEE/Vandenberg AFB comments; respond to AFCEE/Vandenberg AFB comments	September 10, 2004
3	Submit Draft RAW to RWQCB and DTSC	September 30, 2004
4	Receive DTSC and RWQCB comments; respond to RWQCB and DTSC comments	December 6, 2004 and December 23, 2004
5	Submit Draft RAW responses to RWQCB and DTSC comments to AFCEE/Vandenberg AFB	December 21, 2004 and January 20, 2005
6	Receive AFCEE/VAFB approval	December 28, 2004 and January 26, 2005
7	Submit Draft RAW responses to comments to RWQCB and DTSC	January 19, 2005 and January 26, 2005
8	Receive RWQCB and DTSC approval	January 18, 2005 and March 10, 2005
9	Submit Draft Final RAW to DTSC and RWQCB	March 14, 2005
10	Public Comment Period	March 21, 2005 to April 20, 2005
11	Incorporate Public comments if any, issue Final RAW	April 29, 2005
12	Collect 35 Hydropunch samples from Site 32 Cluster	May 5, 2005 to June 16, 2005
13	Receive validated data from groundwater samples; use data to update conceptual site model/select locations for monitoring wells	June 16, 2005 to July 18, 2005
14	Submit Draft Letter Report to AFCEE/Vandenberg AFB	August 1, 2005
15	Receive AFCEE/Vandenberg AFB comments, submit Final Letter Report to DTSC and RWQCB	August 22, 2005
16	Initiate Site 32 IRA and Site 35 Treatability Study -Plant 360 Arroyo Willows -Install 20 monitoring wells and 20 injection wells	September 12, 2005
17	Benchscale study	September 12, 2005 to October 31, 2005
18	Baseline sampling event for Sites 32 and 35	November 14, 2005
19	Injection of vegetable oil substrate	November 21, 2005
20	First Site 32 Cluster quarterly sampling event (fall)	November 28, 2005
21	Submit first Quarterly Monitoring Report	January 16, 2005
22	Second Site 32 Cluster quarterly sampling event (winter)	February 1, 2006
23	Submit second Quarterly Monitoring Report	April 21, 2006
24	Third Site 32 Cluster quarterly sampling event (spring)	May 1, 2006
25	Submit third Quarterly Monitoring Report	June 21, 2006
26	Final Site 32 Cluster quarterly sampling event (summer)	August 1, 2005
27	Submit final Quarterly Monitoring Report	October 20, 2006

Notes: DTSC - Department of Toxic Substances Control
IRA - Interim Removal Action
RWQCB - Regional Water Quality Control Board
RAW- Removal Action Work Plan

Table 3.2-1

Sites 32 and 35 VOCs in Groundwater (Contaminant Summary)

Contaminant of Concern	No. Samples	Range of Detection (µg/L)	Location of Maximum	Cleanup Goal (µg/L)	No. Exceeding Goal
TCE	250	ND–6,200	35-B-9	5	72
cis-1,2-DCE	250	ND–160	35-MW-7	6	26
trans-1,2-DCE	250	ND–2	35-B-9	10	0
Vinyl chloride	250	ND–18.8	35-MW-7	0.5	2

Notes: Data are from winter 1994 through winter 2004; duplicate samples not included in count.
DCE - dichloroethene
µg/L - micrograms per liter
ND – not detected
TCE - trichloroethene

Table 3.4-1
Summary of VOCs Detected in ARCADIS Demonstration Project Wells

	Trichloroethene (µg/L)							
	19-Sep-00	01-Nov-00	02-Aug-01	24-Oct-01	23-Jan-02	17-Apr-02	24-Oct-02	01-May-03
35-MW-7	2,500	600	810	690	410	440	290	260
35-MW-11	NS	450	930	870	27	19	160	260
35-MW-12	4 000	1900	NS	NS	NS	1600	NS	NS
35-MW-13	1,200	720	NS	470	390	420	NS	190
35-MW-14	NS	450	56	NS	NS	50	NS	44
35-MW-15	2,300	1500	NS	1100	870	860	950	930
35-MW-16	2 300	1600	820	770	780	870	980	410
35-MW-17	3,500	1400	NS	NS	NS	840	NS	NS
35-MW-18	230	170	NS	NS	NS	370	710	930
35-MW-19	500	NS	NS	NS	NS	NS	NS	NS
35-MW-19A	NS	NS	NS	1500	NS	NS	NS	270
35-MW-20	NS	410	200	380	NS	230	230	130
35-P-1	250	NS	NS	NS	NS	NS	NS	NS
35-P-2	240	NS	NS	NS	NS	NS	NS	NS
35-P-3	ND	NS	NS	NS	NS	NS	NS	NS
35-H-A*	3.6	NS	NS	NS	NS	NS	NS	NS
35-H-1B*	1,000	NS	NS	NS	NS	NS	NS	NS
35-H-1C*	5,000	NS	NS	NS	NS	NS	NS	NS
35-H-2B*	ND	NS	NS	NS	NS	NS	NS	NS
35-H-2C*	ND	NS	NS	NS	NS	NS	NS	NS

	cis-1,2-DCE (µg/L)							
	19-Sep-00[1]	01-Nov-00	02-Aug-01	24-Oct-01	23-Jan-02	17-Apr-02	24-Oct-02	01-May-03
35-MW-7	ND	11	16	12	11	10	31	59
35-MW-11	NS	9 6	17	15	490	320	190	110
35-MW-12	ND	39	NS	NS	NS	33	NS	NS
35-MW-13	ND	16	NS	9.1	9.7	8 9	NS	10
35-MW-14	NS	14	1.3	NS	NS	1 5	NS	1 1
35-MW-15	ND	39	NS	24	25	21	25	25
35-MW-16	ND	31	24	18	21	21	27	450
35-MW-17	ND	31	NS	NS	NS	18	NS	NS
35-MW-18	8.7	6.2	NS	NS	NS	7.1	140	120
35-MW-19	ND	NS	NS	NS	NS	NS	NS	NS
35-MW-19A	NS	NS	NS	38	NS	NS	NS	250
35-MW-20	NS	9.5	5.9	7.1	NS	72	95	95
35-P-1	ND	NS	NS	NS	NS	NS	NS	NS
35-P-2	3 2	NS	NS	NS	NS	NS	NS	NS
35-P-3	ND	NS	NS	NS	NS	NS	NS	NS
35-H-A*	ND	NS	NS	NS	NS	NS	NS	NS
35-H-1B*	10	NS	NS	NS	NS	NS	NS	NS
35-H-1C*	ND	NS	NS	NS	NS	NS	NS	NS
35-H-2B*	ND	NS	NS	NS	NS	NS	NS	NS
35-H-2C*	ND	NS	NS	NS	NS	NS	NS	NS

	Vinyl Chloride (µg/L)							
	19-Sep-00	01-Nov-00	02-Aug-01	24-Oct-01	23-Jan-02	17-Apr-02	24-Oct-02	01-May-03
35-MW-7	ND	ND	ND	ND	ND	ND	ND	ND
35-MW-11	NS	ND	ND	ND	ND	ND	ND	0.28J
35-MW-12	ND	ND	NS	NS	NS	ND	NS	NS
35-MW-13	ND	ND	NS	ND	ND	ND	NS	ND
35-MW-14	NS	ND	ND	NS	NS	ND	NS	ND
35-MW-15	ND	ND	NS	ND	ND	ND	ND	ND
35-MW-16	ND	ND	ND	ND	ND	ND	ND	26
35-MW-17	ND	ND	NS	NS	NS	ND	NS	NS
35-MW-18	ND	ND	NS	NS	NS	ND	ND	ND
35-MW-19	ND	NS	NS	NS	NS	NS	NS	NS
35-MW-19A	NS	ND	NS	ND	NS	NS	NS	ND
35-MW-20	NS	ND	ND	ND	NS	ND	ND	11
35-P-1	ND	NS	NS	NS	NS	NS	NS	NS
35-P-2	ND	NS	NS	NS	NS	NS	NS	NS
35-P-3	ND	NS	NS	NS	NS	NS	NS	NS
35-H-A*	ND	NS	NS	NS	NS	NS	NS	NS
35-H-1B*	ND	NS	NS	NS	NS	NS	NS	NS
35-H-1C*	ND	NS	NS	NS	NS	NS	NS	NS
35-H-2B*	ND	NS	NS	NS	NS	NS	NS	NS
35-H-2C*	ND	NS	NS	NS	NS	NS	NS	NS

Notes:

*	-	data collected using Hydrosparge technology
1	-	chemical detected on this date is DCE, NOT cis-1,2-DCE
DCE	-	dichloroethene
µg/L	-	micrograms per liter
ND	-	not detected
NS	-	not sampled

Table 6.0-1
Removal Action Implementation Summary

Phase	Scope
Supplemental groundwater investigation	• Collect up to 35 groundwater samples using Hydropunch technology (27 located, 8 proposed step-outs) • Install up to 6 piezometers at 6 Hydropunch locations
Site 32 IRA	• Plant phytoremediation barrier • Install up to 10 monitoring wells • Data acquisition
Site 35 Treatability Study	• Install up to 20 injection wells • Install up to 10 monitoring wells • Inject emulsified soybean oil
Site 32 and 35 monitoring and reporting	• One baseline sampling event followed by four quarterly sampling events. • Generation of four quarterly technical memoranda

Note: IRA – interim removal action

Table 6.2-1
Sites 32 and 35 Sampling Rationale

Sample Location	Approximate Depth Interval (feet bgs)	Rationale
H-A—H-D	35 to bedrock	Samples will be collected at the bedrock/aquifer interface to assess the potential presence of DNAPL in the vicinity of well 35-MW-1 and the Channel 35D discharge area.
H-E—H-K	18 to 25	Samples will be collected at these mid-plume locations near the upper groundwater surface to assess the width of the plume and to refine the injection barrier location.
H-L—H-Q	15 to bedrock	Samples will be collected to assess the nature and extent of groundwater and of VOC contamination southward towards Site 32. Locations H-L through H-Q may be completed as piezometers, to assess local groundwater surface variations. All borings will be completed to bedrock
H-R—H-V	14 to bedrock	Samples will be collected to assess the width of the Site 32 plume as well as refine the location of the phytoremediation barrier.
H-W—H-Y	22 to 27	Samples will be collected at these mid-plume locations near the upper groundwater surface to assess the width of the plume and to refine the phytoremediation barrier location.
H-Z, H-AA	42 to bedrock	Samples will be collected at the bedrock/aquifer interface to assess the potential presence of high VOC concentrations in the vicinity of well 32-MW-7 and channel 32B and 32C discharge areas.

Notes : bgs = below ground surface
DNAPL = dense non-aqueous phase liquid

Table 8.0-1
Sites 32 and 35 Sampling Summary

Sample Type	Frequency	Quantity	Analysis	Analytical Method
Groundwater samples HP-1 through HP-35	1 sample per location, plus 10% are duplicates	39	VOCs	SW8260B
Soil logging from Site 32 Monitoring Wells	Every 10 feet and at lithologic changes	60*	N/A	N/A – Field Lithology
Soil logging from Site 35 Monitoring Wells	Every 10 feet and at lithologic changes	60**	N/A	N/A – Field Lithology
Soil samples from Site 35 Monitoring Wells	N/A	8	Total porosity	ATSM D2937/D854
		8	Grain size analysis	ASTM D422
		8	Effective porosity	SWRCB
		8	Hydraulic conductivity	ATSM D5084
		8	Total organic carbon	Walkley-Black
		8	Specific gravity	ATSM D 854
		8	Moisture density	ASTM D2216/D2937
Groundwater samples from Site 32 Monitoring Wells	Baseline plus Quarterly (5 events)	55	VOCs	SW8260B
Groundwater samples from Site 35 Monitoring Wells	Baseline plus Quarterly (5 events)	55	VOCs	SW8260B
		55	Chloride & sulfate	E300.0
		55	Nitrate	E353.2
		55	Alkalinity	E310.1
		55	Sulfide	E376.2
		55	TOC	E415.2
		55	Methane, ethane, ethane	SW3810M
		55	Metabolic Acids	Ion chromatography

Notes: * - Site 32 total depth assumed to be 30 feet.
** - Site 35 total depth assumed to be 35 feet
N/A – not applicable
TOC - total organic carbon

A SITES 32 AND 35 ADMINISTRATIVE RECORD LIST

Vandenberg AFB, CA
Administrative Record for IRP Site 32 Cluster
Date of Report: 6/29/2004

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1	28-May-02	Administrative Record Index File	URS Corporation	30 CES/CEVR
172	27-Feb-92	Project Note 27, Proposed Limited Investigation at Missile Silo 576-D, SD-032	Acedera, Nestor O Jacobs Engineering Group, Inc.	730 CES/CEVR
174	Mar-92	Soil Gas Survey, SD-032	Jacobs Engineering Group, Inc.	730 CES/CEVR
184	27-Jul-00	CRWQCB Letter to Base Concerning Responses to CRWQCB Comments on the Draft RI Reports for Sites SD-031, SD-032, SD-035, and SS-054	Briggs, Roger W. California Regional Water Quality Control Board	Kephart, Beatrice L. 30 CES/CEVR
213	Jun-92	SI, Missile Silo 576-D, SD-032	Jacobs Engineering Group, Inc.	730 CES/CEVR
219	25-Jun-92	Base Letter to CRWQCB Transmitting Draft Copy of the SD-032, Missile Silo 576-D, SI	Kennedy, George B., Col 730 CES/CEVR	Meece, William California Regional Water Quality Control Board
235	31-Jul-92	CDTSC Letter to Base Concerning RI/FS Work Plan and SD-032 SI	Saebfar, Hamid California Department of Toxic Substances Control	Kennedy, George B., Col 730 CES/CEVR
252	8-Sep-92	CRWQCB Letter to Base Concerning RI/FS Work Plan OU 4 and SD-032 SI	Leonard, William R. California Regional Water Quality Control Board	Kennedy, George B., Col 730 CES/CEVR
438	14-Aug-00	CDTSC Memorandum to Base Concerning Response to Comments, Sites SD-032 and SD-035 RI/FS	Davis, Brian K., PhD California Department of Toxic Substances Control	Bekele, Tizita 30 CES/CEVR

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
475	24-Aug-00	CDTSC Letter to Base Concerning Response to Comments on the Draft Sites SD-032 and SD-035 RI Report	Bekele, Tizita California Department of Toxic Substances Control	Kephart, Beatrice L. 30 CES/CEVR
492	29-Aug-00	CRWQCB Letter to Base Concerning Draft Final Basewide Groundwater Monitoring Program, Work Plan; Sampling and Analysis Plan Addendum; Health and Safety Plan Addendum	Briggs, Roger W. California Regional Water Quality Control Board	Kephart, Beatrice L. 30 CES/CEVR
499	1-Sep-00	CRWQCB Letter to Base Concerning Final Quarter #1 Interim Groundwater Monitoring Reports for Sites SS-003, SS-027, SD-032, SD-033, SD-035	Briggs, Roger W. California Regional Water Quality Control Board	Kephart, Beatrice L. 30 CES/CEVR
686	5-Sep-00	CDTSC Letter to Base Concerning Summary Reports of Costs Incurred by the CDTSC	Hoskins, Larry California Department of Toxic Substances Control	Robbins, Tammy 30 CES/CEVR
742	1-Nov-00	Base Memorandum to CDTSC Concerning Ecological Risk Assessment Meeting, 17 Oct 00	Westfall, Scott W, Lt Col 30 CES/CEV	Scandura, John E California Department of Toxic Substances Control
773	23-Feb-95	RAB Meeting Minutes, 20 Jan 95	730 CES/CEVR	Public
834	11-May-95	RAB Meeting Minutes, 21 Apr 95	730 CES/CEVR	Public
836	10-Apr-95	Tetra Tech Letter to AFCEE Concerning Response to Regulator Comments on PA/SI Surface Water Sampling Plan	McKay-Means, Keli Cummings, Deanna L Tetra Tech, Inc.	Shaffer, Winston J, II, Capt AFCEE/ERD

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
855	Jul-95	Supplemental PA, Draft Report, Vol I of VIII, Sec 1-4	Tetra Tech, Inc.	730 CES/CEVR
856	Jul-95	Supplemental PA, Draft Report, Vol II of VIII, Sec 5-9	Tetra Tech, Inc.	730 CES/CEVR
857	Jul-95	Supplemental PA, Draft Report, Vol III of VIII, Appendices A-B, Areas of Concern	Tetra Tech, Inc.	
858	Jul-95	Supplemental PA, Draft Report, Vol IV of VIII, Appendices C-D, Areas of Interest	Tetra Tech, Inc.	730 CES/CEVR
859	Jul-95	Supplemental PA, Draft Report, Vol V of VIII, Appendices D, Areas of Interest	Tetra Tech, Inc.	730 CES/CEVR
860	Jul-95	Supplemental PA, Draft Report, Vol VI of VIII, Appendices D (continued), Areas of Interest	Tetra Tech, Inc.	730 CES/CEVR
896	20-Oct-95	RAB Meeting Agenda for October	730 CES/CEVR	Public
909	Oct-95	Final PA Report for the Supplemental Basewide PA/SI, Volume I	Tetra Tech, Inc.	730 CES/CEVR
910	Oct-95	Final PA Report for the Supplemental Basewide PA/SI, Volume II	Tetra Tech, Inc.	730 CES/CEVR
911	Oct-95	Final PA Report for the Supplemental Basewide PA/SI, Volume III	Tetra Tech, Inc.	730 CES/CEVR
912	Oct-95	Final PA Report for the Supplemental Basewide PA/SI, Volume IV	Tetra Tech, Inc.	730 CES/CEVR

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
913	Oct-95	Final PA Report for the Supplemental Basewide PA/SI, Volume V	Tetra Tech, Inc.	730 CES/CEVR
914	Oct-95	Final PA Report for the Supplemental Basewide PA/SI, Volume VI	Tetra Tech, Inc.	730 CES/CEVR
915	Oct-95	Supplemental PA, Final Report, Vol VII of VIII	Tetra Tech, Inc.	730 CES/CEVR
916	Oct-95	Supplemental PA, Final Report, Vol VIII of VIII	Tetra Tech, Inc.	730 CES/CEVR
918	Oct-95	Draft Phase I Site Characterization Summary ITIR, SD-035	Tetra Tech, Inc.	730 CES/CEVR
931	11-Dec-95	CDTSC Letter to Base Concerning Final Supplemental PA Report, Vol I – VIII	Gaslan, Milasol C. California Department of Toxic Substances Control	Walter, Douglas B., Lt Col 730 CES/CEVR
935	15-Dec-95	CRWQCB Letter to Base Concerning Draft Phase I Site Characterization Summary ITIR, SD-035	Briggs, Roger W. California Regional Water Quality Control Board	Walter, Douglas B., Lt Col 730 CES/CEVR
958	Nov-95	Draft Phase I Analytical Data ITIR, SD-035	Tetra Tech, Inc.	730 CES/CEVR
973	23-Oct-00	Letter Report, Final Interim Groundwater Monitoring Report, Quarter 2, Winter 2000, SD-032, SD-035	Tetra Tech, Inc.	30 CES/CEVR
985	Mar-96	Draft Final Phase II RI Work Plan, SD-035	Tetra Tech, Inc.	730 CES/CEVR

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1041	Feb-97	Management Action Plan	30 CES/CEVR	30 CES/CEVR
1071	26-Aug-97	CRWQCB Comments on Draft Supplemental Site Inspection Report, June 1997	Briggs, Roger W. California Regional Water Quality Control Board	Caron, Denise R. 30 CES/CEVR
1172	Oct-98	Final Supplemental SI Report	Tetra Tech, Inc.	30 CES/CEVR
1183	23-Dec-98	Final Technical Report, SI/RCRA Facility Assessment of AOCs	Tetra Tech, Inc.	30 CES/CEVR
1187	2-Nov-00	Letter Report, Final Interim Groundwater Monitoring Report, Quarter #3, Spring 2000, SD-032 and SD-035	Tetra Tech, Inc.	30 CES/CEVR
1233	6-Apr-99	CDTSC Letter to Base With Corrections to AOC List Provided in CDTSC's March 16, 1999 Letter	Bekele, Tizita California Department of Toxic Substances Control	Yamauchi, Jack A. 30 CES/CEVR
1283	Jun-99	Management Action Plan, Final Revision 5	30 CES/CEVR	30 CES/CEVR
1285	24-Jun-99	Regional Board Comments on Work Request 10 Final Technical Report and Outstanding Issues Regarding Regional Board Meeting Feb 1, 99 Comments on Work Request 9 Draft Technical Report	Briggs, Roger W. California Regional Water Quality Control Board	Caron, Denise R. 30 CES/CEVR
1420	8-Jun-00	Letter Report, Draft Final Interim Groundwater Monitoring Report Quarter #1, Fall 1999, SD-032 and SD-035	Tetra Tech, Inc.	30 CES/CEVR

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1468	20-Jan-95	RAB Meeting Agenda, 20 Jan 95	30 CES/CEVR	Public
1469	21-Jul-95	RAB Meeting Agenda, 21 Jul 95	730 CES/CEVR	Public
1478	12-Jan-95	Environmental News Release Announcing First Meeting of RAB	730 CES/CEVR, PAO	Public
1479	Apr-95	Base Memorandum to RAB Announcing RAB Meeting, 21 Apr 95	Briggs, James P., Lt Col 730 CES/CEVR	RAB Members
1480	7-Sep-95	Base Letter to RAB with RAB Questionnaire	DeLima, Nedra 730 CES/CEVR, PAO	RAB Members
1481	Aug-94	IRP Fact Sheet – "Seven Stages to Cleanup"	730 CES/CEVR	Public
1482	3-Aug-95	Environmental News Release Announcing VAFB Winning Governor's Environmental and Economic Leadership Award	30 CES/CEVR, PAO	Public
1483	28-Oct-94	CDTSC Memorandum to Office of Military Facilities Regarding Use of EPA Region IX Preliminary Remediation Goals in Screening Risk Assessments at Military Facilities	Wade, Michael J, PhD Valoppi, Laura M. Christopher, John P, PhD California Department of Toxic Substances Control	Smith, Ken Office of Military Facilities
1484	2-Oct-96	Containment Zone Policy – Proposed Amendment to Policies and Procedures for Investigation and Cleanup and Abatement of Water Discharges	California State Water Resources Control Board	

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1485	Feb-97	Final Policy – Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities	California Department of Toxic Substances Control	
1486	Mar-97	Base Letter to CDTSC Concerning Land Use Restrictions	Caron, Denise R. 30 CES/CEVC	Gaslan, Milasol C. California Department of Toxic Substances Control
1488	17-Mar-97	Base Memorandum to CDTSC and CRWQCB Transmitting VAFB Biological Advisory Team Agenda, 26 Mar 97	McElligott, Michael J. 30 CES/CEVCR	Bekele, Tizita California Department of Toxic Substances Control
1493	19-Aug-97	CDTSC Letter to Base Concerning Draft Supplemental SI Report for AOCs	Bekele, Tizita California Department of Toxic Substances Control	Caron, Denise R. 30 CES/CEVC
1494	19-Sep-97	CDTSC Letter to Base Concerning Work Request 9 Work Plan and Report for AOCs	Bekele, Tizita California Department of Toxic Substances Control	Caron, Denise R. 30 CES/CEVC
1495	24-Sep-97	CRWQCB Letter to Base Concerning Work Request 9 Draft Technical Report and Final Work Plans	Briggs, Roger W. California Regional Water Quality Control Board	Caron, Denise R. 30 CES/CEVC
1496	30-Sep-97	CDTSC Letter To Base Concerning No Further Action Concurrence for Twenty-Two AOCs	Scandura, John E. California Department of Toxic Substances Control	Caron, Denise R. 30 CES/CEVC

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1497	17-Oct-97	CDTSC Letter to Base Concerning Correction to No Further Action Concurrence for Twenty-Two AOCs	Scandura, John E. California Department of Toxic Substances Control	Caron, Denise R. 30 CES/CEVC
1499	28-Oct-97	CDTSC Memorandum to DoD Base Commanders and Environmental Coordinators Concerning Division of State Agency Responsibility for CERCLA Remedial Actions	Phillippe, Stan R. Schueller, Harry M. California Department of Toxic Substances Control California Regional Water Quality Control Board	Department of Defense Base Commanders and Environmental Coordinators
1503	24-Nov-97	Base Memorandum to CDTSC Transmitting the Revised Two Year Defense State Memorandum of Agreement (DSMOA) Cooperative Agreement (CA) FY99-00 Work Plan	Caron, Denise R. 30 CES/CEVC	Bekele, Tizita Meece, William California Department of Toxic Substances Control California Regional Quality Control Board
1504	24-Nov-97	Base Memorandum to CRWQCB Transmitting the Revised Two Year Defense State Memorandum of Agreement (DSMOA) Cooperative Agreement (CA) FY99-00 Work Plan	Caron, Denise R. 30 CES/CEVC	Bekele, Tizita Meece, William California Department of Toxic Substances Control California Regional Quality Control Board

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1505	17-Dec-97	CRWQCB Letter to Base Transmitting the Signed Two Year Defense State Memorandum of Agreement (DSMOA) Cooperative Agreement (CA) FY99-00 Work Plan	Briggs, Roger W. California Regional Water Quality Control Board	Caron, Denise R. 30 CES/CEVC
1514	11-Aug-98	CRWQCB Letter to Base Concerning Draft Final Work Plan, SAP, and HSP for UST AOCs	Briggs, Roger W. California Regional Water Quality Control Board	Caron, Denise R. 30 CES/CEVC
1522	9-Feb-99	CDTSC Letter to Base Concerning Response to Comments on Work Request 9 Report for AOCs	Lowe, Sheila California Department of Toxic Substances Control	Caron, Denise R. 30 CES/CEVC
1526	30-Mar-99	CDTSC Letter to Base Concerning State Mid-Term Review of Cooperative Agreement for DSMOA/CA	Scandura, John E. California Department of Toxic Substances Control	Caron, Denise R. 30 CES/CEVC
1528	5-May-99	CRWQCB Fax to Base And CDTSC Transmitting Signed Two Year Work Plan	Meece, William California Regional Water Quality Control Board	Caron, Denise R. Bekele, Tizita 30 CES/CEVC California Department of Toxic Substances Control
1544	15-Nov-99	CRWQCB Letter to Base Concerning Comments on Draft Final RI Work Plan Addendum for AOCs and Meeting Minutes, 01 Nov 99	Briggs, Roger W. California Regional Water Quality Control Board	Kephart, Beatrice L. 30 CES/CEVR

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1551	15-Dec-99	CDTSC Internal Memorandum Concerning Basewide Background for Inorganic Chemicals	Davis, Brian K., PhD California Department of Toxic Substances Control	Bekele, Tizita Patrick, Omoruyi California Department of Toxic Substances Control
1553	24-Dec-99	CDTSC Letter to Base Concerning Basewide Background for Inorganic Chemicals	Bekele, Tizita California Department of Toxic Substances Control	Kephart, Beatrice L. 30 CES/CEVR
1564	Jul-00	IRP Fact Sheet – Geographic Information System	30 CES/CEVR	Public
1577	9-Nov-00	CRWQCB Letter to Base Concerning Comments on Management Action Plan, Draft Final Revision 6	Briggs, Roger W. California Regional Water Quality Control Board	Kephart, Beatrice L. 30 CES/CEVR
1600	Jan-01	Management Action Plan, Final Revision 6	30 CES/CEVR	30 CES/CEVR
1616	1-Feb-01	CRWQCB Letter to Base Concurring with Responses to Comments on the Final Basewide Groundwater Monitoring Program – Work Plan; Sampling and Analysis Plan Addendum; Health and Safety Plan Addendum	Briggs, Roger W. California Regional Water Quality Control Board	Kephart, Beatrice L. 30 CES/CEVR
1623	13-Feb-01	Base Memorandum to CDTSC Concerning the Ecological Risk Assessment Process	Westfall, Scott W., Lt Col 30 CES/CEVR	Scandura, John E. California Department of Toxic Substances Control
1631	18-Feb-01	Santa Maria Times, Public Notice, Community Advisory Board Meeting on February 23, 2001	30 CES/CEVR	Public

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1639	23-Feb-01	CAB Meeting Minutes, 23 Feb 01	30 CES/CEVR	Public
1702	1-Jun-01	CAB Meeting Minutes, 1 Jun 01	30 CES/CEVR	Public
1750	21-Sep-01	CAB Meeting Minutes, 21 Sep 01	30 CES/CEVR	Public
1552	7-Jun-00	Tetra Tech Letter to Base Concerning Revised Responses to CDTSC-HERD Comments on Draft Sites SD-032/SD-035 RI Report	Collinson, Thomas B. Tetra Tech, Inc.	Lewis, Monica AFCEE/ERD
1556	2-Oct-00	CDTSC Letter to Base Concerning Comments on Draft Final RA Work Plan, SD-035	Bekele, Tizita California Department of Toxic Substances Control	Kephart, Beatrice L. 30 CES/CEVR
1571	26-Oct-00	Tetra Tech Letter to Base Transmitting Draft ARARs List for the RA Work Plan, WP-005, SD-035	McNamara, Kevin N. Tetra Tech, Inc.	Kephart, Beatrice L. 30 CES/CEVR
1574	1-Nov-00	Tetra Tech Letter to Base Transmitting Responses to CDTSC Comments on the Draft Final RA Work Plan, SD-035	Elliot, R. James Tetra Tech, Inc.	Atta, Amena 30 CES/CEVR
1612	19-Jan-01	CDTSC Letter to Base Concerning Comments on the Draft Removal Action Work Plan, WP-005, SD-035	Bekele, Tizita California Department of Toxic Substances Control	Kephart, Beatrice L. 30 CES/CEVR
1660	29-Dec-00	Letter Report, Final Basewide Groundwater Monitoring Program Report, Summer 2000, SD-032, Sd-035	Tetra Tech, Inc.	30 CES/CEVR

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1690	4-May-01	CDTSC Letter to Base Approving the Draft Final Removal Action Work Plan, WP-005, SD-035	Yemut, Emad B. California Department of Toxic Substances Control	Kephart, Beatrice L. 30 CES/CEVR
1693	11-May-01	CDTSC Letter to Public Notice Mailing List Concerning Public Review and Comment Period on the Draft Negative Declaration for the Proposed Removal Action, WP-005, SD-035	Yemut, Emad B. California Department of Toxic Substances Control	Public
1782	29-Nov-01	CAB Meeting Minutes, 29 Nov 01	30 CES/CEVR	Public
1796	31-Oct-01	CRWQCB Letter to Base Concerning Comments on Management Action Plan, Draft Final Revision 7	Briggs, Roger W. California Regional Water Quality Control Board	Kephart, Beatrice L. 30 CES/CEVR
1700	31-May-01	Basewide Groundwater Monitoring Program Reports, Winter 2001, SS-002, SS-003, WP-008, Wp-009, WP-010, WP-013, SD-014, LF-020, SD-025, SS-027, SD-031, SD-032, SD-033, SD-035, ST-060	Tetra Tech, Inc.	30 CES/CEVR
1715	Jul-01	Final Removal Action Work Plan, WP-005, SD-035	Tetra Tech, Inc.	30 CES/CEVR
1720	12-Jul-01	CDTSC Letter to Base Approving the Final Removal Action Work Plan, WP-005, SD-035	Scandura, John E. California Department of Toxic Substances Control	Kephart, Beatrice L. 30 CES/CEVR
1753	Oct-01	Interim Removal Action Closure Report, SD-035	Tetra Tech, Inc.	30 CES/CEVR

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1758	5-Oct-01	CDTSC E-mail to Base Providing Comments on the Interim Removal Action Closure Report, SD-035	Chang, Ning-Wu, PhD California Department of Toxic Substances Control	Kephart, Beatrice L. 30 CES/CEVR
1763	22-Oct-01	CDTSC Letter to Base Approving the Interim Removal Action Closure Report, SD-035	Scandura, John E. California Department of Toxic Substances Control	Kephart, Beatrice L. 30 CES/CEVR
1769	21-Jun-01	Final Negative Declaration for CERCLA Removal Action, WP-005, SD-035	Scandura, John E. California Department of Toxic Substances Control	Public
1770	21-Jun-01	California Environmental Quality Act Final Special Initial Study for CERCLA Removal Action, WP-005, SD-035	California Department of Toxic Substances Control	Public
1781	26-Nov-01	Basewide Groundwater Monitoring Program Reports, Summer 2001, SS-002, WP-008, WP-009, WP-010, WP-013, SD-014, SD-015, SD-019, LF-020, SD-025, SS-027, SD-031, SD-032, SD-033, SD-035, ST-060	Tetra Tech, Inc.	30 CES/CEVR
1804	Dec-01	Management Action Plan, Final Revision 7	30 CES/CEVR	30 CES/CEVR
1808	7-Feb-02	CAB Meeting Minutes 07 Nov 02	30 CES/CEVR	Public
1821	28-Nov-01	RPM Meeting Minutes, 28 Nov 01	30 CES/CEVR	30 CES/CEVR
1822	6-Feb-02	RPM Meeting Minutes, 06 Feb 02	30 CES/CEVR	30 CES/CEVR

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
1825	11-Aug-00	Letter Report, Final Interim Groundwater Monitoring Report, Quarter 1, Fall 1999, SD-032, SD-035	Tetra Tech, Inc.	30 CES/CEVR
1829	23-Oct-00	Letter Report, Final Interim Groundwater Monitoring Report, Quarter #2, Winter 200, SD-032, SD-035	Tetra Tech, Inc.	30 CES/CEVR
1833	2-Nov-00	Letter Report, Draft Final Interim Groundwater Monitoring Report, Quarter #3, Spring 2000, SD-032 and SD-035	Tetra Tech, Inc.	30 CES/CEVR
	31-May-02	Basewide Groundwater Monitoring Program Reports, Winter 2002, Installation Restoration Program (IRP) Sites 2, 8 Cluster, 13 Cluster, 15, 19, 20 Area 1, 20 Areas 2 and 3, 25 Cluster, 27, 31, 32 Cluster, 33, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD
	10-Sep-02	Basewide Groundwater Monitoring Program Reports, Spring 2002, Installation Restoration Program (IRP) Sites 1, 2, 3, 8 Cluster, 13 Cluster, 15, 19, 20 Areas 2 and 3, 25 Cluster, 27, 31, 32 Cluster, 33, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD
	13-Nov-02	Basewide Groundwater Monitoring Program Reports, Summer 2002, Installation Restoration Program (IRP) Sites 2, 8 Cluster, 13 Cluster, 15, 19, 20 Area 1, 20 Areas 2 and 3, 25 Cluster, 27, 31, 32 Cluster, 33, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
	31-Jan-03	Basewide Groundwater Monitoring Program Reports, Fall 2002, Installation Restoration Program (IRP) Sites 1, 2, 3, 5 Cluster, 8 Cluster, 13 Cluster, 15, 19, 20 Areas 2 and 3, 25 Cluster, 27, 31, 32 Cluster, 33, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD
	23-May-03	Basewide Groundwater Monitoring Program Reports, Winter 2003, Installation Restoration Program (IRP) Sites 2, 5 Cluster, 8 Cluster, 13 Cluster, 15, 19, 20 Area 1, 20 Areas 2 and 3, 25 Cluster, 27, 31, 32 Cluster, 33, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD
	24-Oct-03	Basewide Groundwater Monitoring Program Reports, Spring 2003, Installation Restoration Program (IRP) Sites 1, 2, 3, 5 Cluster, 8 Cluster, 13 Cluster, 15, 19, 20 Areas 2 and 3, 25 Cluster, 31, 32 Cluster, 33, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD
	5-Feb-04	Basewide Groundwater Monitoring Program Reports, Summer 2003, Installation Restoration Program (IRP) Sites 2, 5 Cluster, 8 Cluster, 13 Cluster, 15, 19, 20 Area 1, 20 Areas 2 and 3, 25 Cluster, 27, 31, 32 Cluster, 33, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD

AR #	Document Date	Subject or Title	Author or Corporate Author	Recipient
	7-Apr-04	Basewide Groundwater Monitoring Program Reports, Fall 2003, Installation Restoration Program (IRP) Sites 1, 2, 3, 5 Cluster, 8 Cluster, 13 Cluster, 15, 19, 20 Areas 2 and 3, 25 Cluster, 31, 33, AOC 59, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD
	4-Jun-04	Basewide Groundwater Monitoring Program Reports, Winter 2004, Installation Restoration Program (IRP) Sites 2, 5 Cluster, 8 Cluster, 13 Cluster, 15, 19, 20 Area 1, 20 Areas 2 and 3, 25 Cluster, 27, 31, 32 Cluster, 33, and 60, Vandenberg Air Force Base, California	Tetra Tech, Inc.	30 CES/CEVR HQ AFCEE/ERD
	Jun-04	Draft Final Remedial Investigation Report, Site 32 Cluster - Site 32 (Missile Silo 576-D) and Site 35 (Missile Silo 576-G) OU 4 Remedial Investigation Feasibility Study, Volume I	Tetra Tech, Inc.	30 CES/CEV

B APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Chemical-Specific ARARs					
Safe Drinking Water Act, 42 USC 300					
1	National Primary Drinking Water Standards	40 CFR, Part 141	Establishes maximum contaminant levels (MCLs) for public water systems	Relevant & Appropriate	The NCP defines MCLs as relevant and appropriate for groundwater determined to be a current or potential source of drinking water in cases where MCLGs are not ARARs. Groundwater in the vicinity of VAFB has been designated for potential drinking water use.
2	Maximum Contaminant Level Goals (MCLGs)	40 CFR, Part 141	Establishes potable water quality goals.	Relevant & Appropriate	MCLGs that have non-zero values are relevant and appropriate for groundwater to be a current or potential source of drinking water. Groundwater in the vicinity of VAFB has been designated for potential drinking water use.
Clean Water Act, 33 USC 1251 et seq.					
3	Water Quality Standards and Criteria	33 USC, 1313 and 57, Federal Register 60920-60921	Establishes the requirement or water quality standards for discharges to waters of the United States	Potentially Relevant & Appropriate	Applies to any potential site discharge to waters of the United States.
Hazardous Waste Control Act (HWCA)					
4	Concentration limits of regulated units effluent to groundwater, surface water, and soil	Title 22, CCR, Div 4.5, Ch 14, §66264.94	Groundwater and vadose zone protection standards: RCRA hazardous waste TSD facilities shall comply and ensure that hazardous constituents entering the groundwater, surface water, and soil from a regulated unit do not exceed the concentration limit from contaminants of concern in the uppermost aquifer underlying the waste management area beyond the point of compliance.	Potentially Relevant & Appropriate	Applicable for hazardous waste TSD facilities; potentially relevant and in site-specific circumstances, such as when the source of waste is unknown but the waste is similar in composition to listed waste or when waste constituents have released or have the potential to release to groundwater. This site is not a TSD facility, and existing concentrations of constituents present in site mdeia are generally below levels that would classify them as hazardous waste.
5	Hazardous waste listing and identification	Title 22, CCR, Div 4.5, Ch 11, §66261.2, §66261.3	Identification of hazardous waste that poses a potential hazard to human health or the environment when it is improperly treated, stored, transported, or disposed.	Potentially Relevant & Appropriate	Hazardous waste determinations for soil cuttings generated from well installations and any extracted groundwater (e.g., purge water) will be made at the time that wastes are generated.
Resource Conservation and Recovery Act (RCRA)					
6	RCRA Hazardous Waste and toxic characteristics leaching procedure (TCLP) levels	Title 22, CCR	Defines RCRA hazardous waste and TCLP regulatory levels.	Potentially Relevant & Appropriate	Hazardous waste determinations for soil cuttings generated from well installations and any extracted groundwater (e.g., purge water) will be made at the time that wastes are generated.
Cal/EPA DTSC					
7	Non RCRA Hazardous Waste; persistent and bioaccumulative toxic substances, total threshold limit concentrations (TTLCs), and soluble threshold limit concentrations (STLCs).	Title 22, CCR, Div 4.5, Ch. 11	Defines non-RCRA hazardous waste, persistent and bioaccumulative toxic substances, and regulatory levels for TTLC and STLC analyses.	Applicable	Hazardous waste determinations for soil cuttings generated from well installations and any extracted groundwater (e.g., purge water) will be made the time that wastes are generated.
8	State maximum contaminant level (MCL) list	Title 22, CCR, Div 4, Ch. 15	The primary MCLs are drinking water quality standards established by the U.S. EPA under the Safe Drinking Water Act, the State of California under Domestic Water Quality and Monitoring Regulations. Primary MCLs present risk to the human health when used for drinking or culinary purposes.	Relevant & Appropriate	State MCLs are tap water standards that are relevant and appropriate for the potential drinking water aquifers at VAFB.
9	State Secondary MCL list	Title 22, CCR, Div 4, Ch15	Secondary MCLs may be objectionable to an appreciable number of people but are not generally hazardous to human health.	Potentially Relevant & Appropriate	None of the chemicals of concern for the Site 32C IRA have secondary MCLs.
State and Regional Water Quality Control Board (RWQCB)					
10	Porter Cologne Water Quality Control Act (California Water Code Sections 13240, 13241, 13242, 13243)	Water Quality Control Plan (Basin Plan) for the RWQCB, CCR includes the State Water Resources Control Board's Water Quality Control Plan for Ocean Waters of California (Ocean Plan)	Establishes water quality objectives, including narrative and numerical standards, that protect the beneficial uses and water quality objectives of surface and ground waters in the region. Describes implementation plans and other control measures designed to ensure compliance with statewide plans and policies and provide comprehensive water quality planning.	Applicable	Specific applicable portions of the Basin Plan include beneficial uses of affected water bodies and water quality objectives to protect those uses. Any activity, including, but not limited to, the discharge of contaminated soils or waters or in-situ treatment or containment of contaminated soils or waters, must not result in actual water quality exceeding water quality objectives. The Basin Plan for RWQCB CCR assigns the beneficial use of drinking water to all groundwater in the region (with the exception of the Soda Lake sub-basin). The Basin Plan supercedes Resolution 88-63, therefore, the beneficial use of drinking water must be protected regardless of the Resolution's criteria.
11	Porter Cologne Water Quality Control Act (California Water Code Sections 13000, 13140, 13240)	State Water Resources Control Board Resolution (SWRCB) 88-63 (Source of Drinking Water Policy)	Designates all ground and surface waters of the State as drinking water except where the TDS is greater than 3,000 ppm, the well yield is less than 200 gpd from a single well, the water is a geothermal resource or in a water conveyance facility, or the water cannot reasonably be treated for domestic purposes using either best management practices or best economically achievable treatment practices.	Applicable	Applies in determining beneficial uses for waters that may be affected by discharges of waste. The groundwater at VAFB has been identified as a source of drinking water.

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Chemical-Specific ARARs					
State and Regional Water Quality Control Board (RWQCB)					
12	Policy Regarding Maintenance of Water Quality in California	SWRCB Resolution 68-16 (Policy with Respect to Maintaining High Quality Waters in California)	Requires that quality of waters of the State is better than needed to protect all beneficial uses be maintained unless certain findings are made. Discharge to high quality waters must be treated using best practicable treatment or controls necessary to prevent pollution or nuisance and to maintain the highest quality water. Requires cleanup to background water quality or to lowest concentrations technically and economically feasible to achieve Beneficial uses must, at least, be protected.	Applicable	Applicable for any surface discharge or subsurface injection of treated water.
13	Porter-Cologne Water Quality Control Act	Water Code, Div. 7, §13000 et seq.	Establishes authority of State and Regional Water Boards to protect water quality by regulating waste disposal and requiring cleanup of hazardous conditions that affect waters of the state. Defines designated waste; sets requirements for laboratories; sets report requirements for waste discharges and specifies well drilling requirements and reporting.	Applicable	Defines waste and sets requirements for investigations and analyses.
14	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20400, Title 23, CCR, §2550.4.	Concentration limits must be established for groundwater, surface water, and the unsaturated zone. Must be based on background, equal to background, or for corrective actions, may be greater than background, not to exceed the lower of the applicable water quality objective or the concentration technologically or economically achievable. Specific factors must be considered in setting cleanup standards above background levels.	Applicable	Applies in setting ground water cleanup levels for any discharges of waste to land.
15	California Safe Drinking Water Act (California Health & Safety Code Section 4010 et seq.)	Title 22, CCR, §64400 et seq.	Requirements for public water systems. includes MCLs and Secondary MCLs.	Relevant & Appropriate	The act is legally applicable for an aquifer and associated distribution and pre-treatment system that is currently defined as "public water system" If it is only a potential "Public water system," then the act is relevant and appropriate.
16	Safe Drinking Water & Toxic Enforcement Act (aka Prop. 65)	Health and Safety Code, Division 20, Chapt. 6.6, §25249.5 et seq.	Prohibits discharges of specified carcinogens and reproductive toxins into current or potential drinking water sources.	Relevant & Appropriate	Prohibits discharges of specific substances to drinking water sources.

TO BE CONSIDERED STATE ADVISORIES, GUIDANCE, AND CRITERIA, CAL/EPA, DTSC

1 *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities*
DTSC Human and Ecological Risk Division

2 *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities*
DTSC Human and Ecological Risk Division

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Location-Specific ARARs					
17	National Archaeological and Historical Preservation Act	16 USC, 469a-1 and 36 CFR 65	Construction on previously undisturbed land would require an archaeological survey of the area	Applicable	Archaeological surveys have been conducted at VAFB: archaeological monitors should to be present to clear all drilling locations in order to protect cultural resources.
18	Endangered Species Act of 1973	16 USC, 1536(a)	Action to protect critical habitat upon which endangered species or threatened species depend must be taken.	Applicable	Sensitive habitat mitigation measures will be followed during implementation of this IRA.
19	Fish and Game Code	Fish and Game Code, §2080	No person shall import, export, take, possess, or sell any endangered or threatened species or part of product thereof.	Potentially Applicable	Endangered species are present at VAFB.
20	Within 200 feet of a fault displacement in Holocene time	Title 22, CCR, Div 4.5, Ch 14, §66264.18	New facility for treatment, storage, or disposal of hazardous waste prohibited.	Potentially Relevant & Appropriate	The location requirements are considered relevant and appropriate for the siting of remedial systems to reduce the toxicity, volume and/or mobility of chemicals. However, IRA treatment system is in-situ (i.e. trench installation or planting trees); not a conventional constructed system.
21	Within a 100-year floodplain	Title 22, CCR, Div 4.5, Ch 14, §66264.18	Facility must be designed, constructed, operated, and maintained to prevent washout by flood or maximum high tide.	Potentially Relevant & Appropriate	Same as above
22	Porter-Cologne Water Quality Control Act (California Water Code Section 13000 et seq.)	California Water Code, §13243	The RWQCB may specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted.	Applicable	Applies to groundwater remedial action.

TO BE CONSIDERED STATE ADVISORIES, GUIDANCE, AND CRITERIA, CAL/EPA, DTSC

1 *Drilling, Coring, Sampling and Logging at Hazardous Substance Release sites*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

2 *Reporting Hydrogeologic Characterization Data at Hazardous Substance Release sites*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

3 *Guidelines for Hydrogeologic Characterization of Hazardous Substance Release Sites, Volume 1 & 2*
Cal/EPA, July 1995

4 *Aquifer Testing for Hydrogeologic Characterization*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

5 *Application of Borehole Geophysics at Hazardous Substance Release Sites*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

6 *Ground Water Modeling for Hydrogeologic Characterization*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

7 *Monitoring Well Design and Construction for Hydrogeologic Characterization*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

8 *Advisory – Active Soil Gas Investigation*
DTSC/CRWQCB-Los Angeles Region, January 2003

9 *Representative Sampling of Ground Water for Hazardous Substances*
Cal/EPA, July 1995

10 *Accumulating Hazardous Waste at Generator Sites*
Cal/EPA, July 1995

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Action-Specific ARARs					
23	Offsite Management Requirements for CERCLA Wastes	58 CFR 49200-49218 40 CFR 300.440	Establishes requirements for managing CERCLA response action wastes at offsite Treatment, Storage and Disposal (TSD) facilities.	Applicable	Applicable for off-site treatment or disposal of removed materials (e.g., drill cuttings, construction materials, or purge waters).
24	National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122-125	Requires permits for the discharge of pollutants from any point source into the waters of the United States.	Relevant & Appropriate	No discharge to grade planned for IRA; however, best management practices will be implemented to protect storm water discharges.
25	Hazardous Waste Control Act (HWCA)	Title 22, CCR, Div 4.5, §66262.10(a), §66262.11	Requires that the generator shall determine if a waste is hazardous waste.	Applicable	Applicable for any operation where waste is generated.
26	HWCA	Title 22, CCR, Div, 4.5, §66262.34	Generator may accumulate waste on site for 90 days or less or must comply with requirements for operating a storage facility	Applicable	No storage of hazardous waste is planned as part of this IRA. Accumulation of hazardous wastes on site for longer that 90 days would be subject to RCRA requirements for storage facilities.
27	HWCA	Title 22, CCR, Div 4.5, §66262.40, §66262.41	Generator must keep records of manifests, test results and waste analyses.	Applicable	Applicability of this requirement is contingent upon generation and management of hazardous waste.
28	HWCA	Title 22, CCR, Div 4.5, Ch 12, §66262.12	A generator shall not treat, store, dispose of, transport or offer for transportation, hazardous waste without having received an identification number.	Applicable	Applicable for any operation where waste is generated. The determination of whether wastes generated during remedial activities are hazardous shall be made when the wastes are generated.
29	HWCA	Title 22, CCR, Div 4.5, Ch 12, §66262.20, §66262.22	A generator of hazardous waste who transports or offers hazardous waste for transportation shall prepare a manifest.	Applicable	Same as above.
30	HWCA	Title 22, CCR, Div 4.5, Ch 12, §66262.30, §66262.31, §66262.32, and §66262.33	Before transporting hazardous waste or offering hazardous waste for transportation off-site, the generator must do the following in accordance with DOT regulations: package the waste, label and mark each package of hazardous waste, and ensure that the transport vehicle is correctly placarded.	Applicable	Same as above.
31	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 2	Establish requirements for a hazardous waste treatment facility to have a plan for waste analysis, develop a security system, conduct regular inspections, provide training to facility personnel, and use a quality assurance program during construction.	Potentially Relevant & Appropriate	Sites 32 and 35 are not a TSD facility. The determination of whether wastes generated during remedial activities are hazardous shall be made when the wastes are generated.
32	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 3, 4	Establish requirements for a facility to plan for emergency conditions. In addition, the design and operation of the facility must be done to prevent releases. Other requirements include testing and maintenance of equipment and incorporation of communication and alarm systems and contingency plan.	Potentially Relevant & Appropriate	Same as above.
33	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 9	The remedial activities may involve treatment within containers and/or storage of treatment residuals in containers. These containers must be in good condition, compatible with the waste, kept closed except to add or remove materials and be inspected weekly. The area used to store the containers must provide adequate secondary containment and be designed with runoff controls. Also, appropriate closure of the containers must take place.	Relevant & Appropriate	The requirements may be applicable if CERCLA response action constitutes treatment, storage, or disposal as defined under RCRA, or may be relevant and appropriate if the requirements address problems or situations sufficiently similar to the specific circumstances at the site that their usage will be well suited. Sites 32 and 35 are not a TSD facility, and treatment is in-situ (i.e. no tanks are specified to be used).
34	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 10	The remedial activities may involve storage and/or treatment in tanks. These tanks are required to have secondary containment, be monitored and inspected, be provided with overfill and spill protection controls, and operated with adequate freeboard. Also, appropriate closure must take place.	Relevant & Appropriate	Same as above.
35	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 12	The waste piles should be placed upon a lined foundation or base with a leachate system, protected from precipitation and wind dispersal, designed to prevent run on and run off. Also, closure and post-closure care requirements.	Relevant & Appropriate	Remedial action may involve soil excavation and the compiling of soil in a temporary waste pile for the injection barrier.

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Action-Specific ARARs					
36	HWCA	Title 22, CCR, Div 4.5, Ch 18, Article 1, 3, 4, 10, 11	Movement of hazardous waste to new locations and placed in or on land will trigger LDR. General applicability, dilution prohibited, waste analysis and record keeping, and special rules apply for wastes that exhibit a characteristic waste. Best Demonstrated Available Technology (BDA) standards for each hazardous constituents in each listed waste, if residual is to be disposed. Treatment standards table when necessary.	Applicable	Where applicable, hazardous waste generated from remedial activities must comply with LDR and meet or notify the disposal facility of the treatment standards before disposal at an appropriate offsite disposal facility.
37	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.111, §66264.112, §66264.115 through 120	Owners and operators shall close a facility and perform post-closure care when contaminated subsurface soil cannot be practically removed or decontaminated.	Relevant and Appropriate	Contaminated soil, residues, or groundwater from remedial action at a site will achieve clean closure, otherwise, post-closure care requirements will be relevant and appropriate.
38	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.91 (a) and (c)	Owners or operators of a RCRA surface impoundment, waste pile, land treatment unit, or landfill shall conduct a monitoring and response program for each regulated unit.	Relevant and Appropriate	Substantive technical requirements are potentially relevant and appropriate for remedial action including groundwater monitoring.
39	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.97 (b), (c), (d) and (e)(1) through (e)(5)	Requirements for monitoring groundwater, surface water, and vadose zone.	Relevant and Appropriate	Same as above
40	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.193 (b) and (c)	In order to prevent release of hazardous constituents to the environment, tank systems, including ancillary equipment, shall have secondary containment (e.g., double-wall piping).	Relevant and Appropriate	Potentially applicable to conventional remedial systems; however, only wells comprised the remedial alternatives considered in this IRA.
41	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.98	Requires the owner or operator of a regulated unit to develop a detection monitoring program that will provide reliable indication of a release.	Relevant and Appropriate	Same as above
42	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.99	Requires the owner or operator of a regulated unit to develop an evaluation monitoring program that can be used to assess the nature and extent of a release from the unit.	Relevant and Appropriate	Same as above
43	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.100 (a) through (d), (f), (g)(1), and (h)	The owner or operator is required to take corrective action under Title 22, CCR, §66264.91 to remediate releases from the regulated unit and to ensure that the regulated unit achieves compliance with the water quality protection standard.	Relevant and Appropriate	Same as above
44	Safe Water Drinking Act (SFDA), Underground Injection Control (UIC) Regulations Toxic Injection Well Control Act of 1985	40 CFR, §260.10 Parts 144 through 147 Cal. Health and Safety Code, §25159.10 through 25	Establishes minimum requirements for UIC programs such as permits for the injection wells. Injection may not cause a violation of the primary MCLs and requires the evaluation of the quality of water.	Applicable	Potentially applicable for alternative utilizing a groundwater injection option to aquifers that are or may reasonable be expected to be a source of drinking water. If the treated water is most likely to be at or below the applicable primary MCLs, it is highly unlikely to be classified as either a RCRA or non-RCRA hazardous waste. Consequently, the reinjection wells would be Class V wells under SDWA UIC regulations. The substantive requirements of UIC regulations for Class V wells need to be met.
45	California Health and Safety Code California Civil Code	Cal. Health and Safety Code, §25202.5, 25222.1 Cal. Civil Code, §1471	Allows DTSC to enter into an agreement with the owner of a hazardous waste facility to restrict present and future land usages. Provides a streamlined process to be used for entering into an agreement to restrict specific usage of property in order to implement land-use restrictions	Relevant and Appropriate	The substantive provisions of Cal. Health and Safety Code (HSC), §25202.5 are the general narrative standards to restrict "[p]resent and future uses of all or part of the land on which the … facility … is located …" HSC §25222.1 provides the authority for the state to enter into voluntary agreement to establish land-use covenants with the owner of the property. The substantive provision of this section is the general narrative standard "[restricting specified uses of the property]". Cal. Civil Code §1471 provides conditions under which land-use restrictions will apply to successive owners of land.
46	Occupational Health and Safety Act	Cal. Health and Safety Code, Div 5, §6300 et seq.	Specific requirements that employers must meet to ensure the safety of the employees	Relevant and Appropriate	The provisions of this act should be followed for the removal action. A health and safety plan has been developed for the proposed removal action and is contained in the IRA Work Plan.

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Action-Specific ARARs					
47	CCR	Title 22, CCR, §66264	Container storage requirements and storage time limitations	Applicable	Applicability of this requirement is contingent upon generation and management of hazardous waste.
48	U.S. Department of Transportation	49 CFR, 171-172	Regulates storage, packaging, labeling, and placarding requirements for hazardous materials with regards to transportation.	Applicable	Portions of these requirements would be ARARs for transport of material on site. Off-site transport must comply with both substantive and administrative requirements.
49	State Hazardous Waste Regulations Discharges of Waste to Land	Title 23, CCR, §2510-§2600	Regulates waste discharges to land that may affect water quality. Includes siting, design, construction, operation, closure and monitoring standards and criteria for establishing cleanup levels.	Applicable	Substantive requirements of these regulations are applicable at Site 32C.
50	Hazardous Waste Control Act as implemented by Standards for Generators of Hazardous Waste	Health and Safety Code, Sec. 25100 et seq., Title 22, CCR, Div. 4.5, §66262	Establishes state hazardous program in lieu of federal RCRA. Establishes standards for generators and transporters of hazardous wastes in California. Authorization for state program was obtained from U.S. EPA in 1992. Establishes recordkeeping, reporting and manifesting standards for hazardous waste generators in California. Establishes storage accumulation time, requires hazardous waste determination, specifies labeling, container segregation of incompatible wastes, and secondary containment requirement.	Applicable	CERCLA sites are exempt from these administrative requirements. Substantive requirements will apply for any offsite transportation of wastes from Site 32C.
51	Hazardous Waste Control Act as implemented by Land Disposal Restrictions	Title 22, CCR, Div. 4.5, §66268	Identifies wastes and chemical concentration levels that are restricted from land disposal.	Applicable	Will be applicable for drill cuttings or treatment residuals with chemical concentrations exceeding regulatory levels.
52	Hazardous Waste Control Act as implemented by Corrective Action Management Units (CAMU)	Title 22, CCR, Div. 4.5, §66264.552	Establishes location and operating requirements for Corrective Action Management Units used in remedial actions.	Applicable	Applicable for treatment units for excavated soil (e.g., drill cuttings), landfilled material, or extracted water. Applies to both RCRA and non-RCRA wastes.
53	Hazardous Waste Control Act as implemented by Temporary Units	Title 22, CCR, Div. 4.5, §66264.553	Allows Department of Toxic Substances Control (DTSC) to approve design, operation and closure standards for temporary units used for treatment or storage of wastes generated during remedial actions. DTSC may require alternative standards more protective of human health and the environment.	Relevant & Appropriate	Relevant and appropriate for remedial alternatives that include the use of temporary on-site treatment units.
54	Hazardous Waste Control Act as implemented by Miscellaneous Units	Title 22, CCR, Div. 4.5, §66264.600-§66264.603	Establishes standards for environmental performance, monitoring, inspections and post-closure care for miscellaneous units used in waste treatment, storage, or disposal.	Applicable	Substantive portions will be applicable for remedial alternatives.
55	Water Well Standards	Dept. of Water Resources Bulletin 74-81 and 74-90	Sets requirements for the construction and abandonment of water extraction and injection wells throughout the state.	Applicable	Will apply for any monitoring, injection, or extraction wells constructed or abandoned during remedial actions.
56	Waste Discharge Requirements	Water Code Sec. 13260 et seq. (Porter-Cologne Water Quality Control Act)	Requires filing of a "Report of Waste Discharge" with the RWQCB for any proposed discharges affecting "the waters of the state."	Potentially Applicable	Under CERCLA, on-site actions are exempt from reporting requirements. However, the reporting requirement must be met for any offsite discharges.
57	Policies and Procedures for Investigation and Cleanup and Abatement and Closure	California Water Code 13304 as implemented by State Water Resources Control Board Resolution No. 92-49	Establishes policies and procedures for oversight of investigations, cleanups and abatement activities resulting from discharges which affect or threaten water quality.	Applicable	Applicable for all cleanup and abatement activities which may cause or permit discharges to waters of the state and create or threaten to create a condition of pollution or nuisance in violation of any waste discharge requirement.
58	Hazardous Materials Release Response Plans and Inventory	Health and Safety Code, Div. 20, Chapter 6.95	Establishes requirements for emergency response plans for a release or threatened release of hazardous materials. Reporting requirements are established.	Applicable	Substantiative requirements will be applicable to sites with remedial actions where hazardous materials may be handled.
59	Staff Report of the RWQCB, CVR	"A Compilation of Water Quality Goals"	Provides guidance on selecting numerical values to implement narrative water quality objectives contained in the Basin Plan.	To Be Considered	Performance Standard. To be considered in selecting appropriate numerical values to implement the Basin Plan for setting cleanup levels and discharge limits. The numerical values contained in the staff report may be ARAR's, or Performance Standards, depending on the source of the values.

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Action-Specific ARARs					
60	Porter-Cologne Water Quality Control Act (California Water Code Sections 13000, 13140, 13240, 13260, 13263, 13267, 13300, 13304, 13307)	State Water Resources Control Board Resolution No. 92-49 (As amended April 21, 1994)	Establishes requirements for investigation and cleanup and abatement of discharges. Among other requirements, dischargers must clean up and abate the effects of discharges in a manner that promotes the attainment of either background water quality, or the best water quality that is reasonable if background water quality cannot be restored. Requires the application of Title 23, CCR, Section 2550.4, requirements to cleanups.	Applicable	Applies to groundwater remedial actions.
61	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20090(d), Title 23, CCR. §2511 (d)	Action taken by public agencies to clean up unauthorized releases are exempt from Title 27/ Title 23 accept that wastes removed from immediate place of release and discharged to land must be managed in accordance with classification (Title 27, CCR, Section 20200/ Title 23, CCR, Section 2520) and siting requirements of Title 27 or Title 23 and wastes contained or left in place must comply with Title 27 or Title 23 to the extent feasible.	Applicable	Applies to remediation and monitoring of sites.
62	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20410, Title 23, CCR, §2550.6	Requires monitoring for compliance with remedial action objectives for three years from the date of achieving cleanup standards.	Applicable	Applies to groundwater remedial actions.
63	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20415, Title 23, CCR, §2550.7.	Requires general soil, surface water, and ground water monitoring.	Applicable	Applies to all areas at which waste has been discharged to land.
64	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title, 27, CCR, §20425, Title, 23, CCR, §2550.9.	Requires an assessment of the nature and extent of the release, including a determination of the spatial distribution and concentration of each constituent.	Applicable	Applies to areas at which monitoring results show statistically significant evidence of a release.
65	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20430, Title 23, CCR §2550.10	Requires implementation of corrective action measures that ensure that cleanup levels are achieved throughout the zone affected by the release by removing the waste constituents or treating them in place. Source control may be required. Also requires monitoring to determine the effectiveness of the corrective actions.	Applicable	Applies to groundwater remedial actions.

TO BE CONSIDERED STATE ADVISORIES, GUIDANCE, AND CRITERIA, CAL/EPA, DTSC

- *Institutional Control Protocol at Open Bases*
  California Military Environmental Coordination Committee (CMECC)
  Site Cleanup Performance Action Team

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C HEALTH AND SAFETY PLAN ADDENDUM

HEALTH AND SAFETY PLAN ADDENDUM

This Health and Safety Plan addendum summarizes pertinent health and safety information and procedures required to conduct field work at the Site 32 Cluster The Site Cluster consists of Missile Silo 576 D and 576 G Vandenberg AFB, California. The addendum is intended to augment the following documents: Installation Restoration Program RI/FS Health and Safety Plan (JEG 1993b), the Tetra Tech Corporate Health and Safety Manual (Tetra Tech 1999), the Basewide SAP (Tetra Tech 2003), site-specific Health and Safety Plans for field operations (Tetra Tech 1993), and previous training received by field participants. The above-mentioned documents are available for review or reference at the Tetra Tech field trailer, located at the Agena Tank Farm IDW Storage Area at Vandenberg AFB, and in the Santa Barbara, California, office.

This document also addresses the regulatory requirement in 29 Code of Federal Regulations (CFR) 1910.120 (b)(4) and CCR 5192 (b)(4) regarding site-specific health and safety plans.

C.1 FACILITY DESCRIPTION

Vandenberg AFB is located on the south-central coast of California, approximately halfway between San Diego and San Francisco. The base covers approximately 98,000 acres in western Santa Barbara County and is headquarters for the 30th Space Wing. The primary mission of the 30th Space Wing at Vandenberg AFB is to launch and track satellites in space, test and evaluate America's intercontinental ballistic missile systems, and support aircraft operations in the western range. As a nonmilitary facet of operations, Vandenberg AFB is also committed to promoting commercial space launch ventures.

C.1.1 Demographics

Vandenberg AFB supports approximately 12,000 personnel, comprising Air Force personnel, civilian employees, contractors, and military dependents. Approximately 2,080 family housing units are located in the main cantonment area. The nearby cities of Lompoc and Santa Maria have populations of 37,649 and 70,811, respectively.

C.1.2 Climate

The climate at Vandenberg AFB remains relatively mild and constant throughout the year. The prevailing wind direction is to the east and southeast. The climate is categorized as subtropical (Mediterranean), receiving modest precipitation during the winter months (December through March), and little or no precipitation the rest of the year.

The Vandenberg AFB 30th Weather Squadron compiles climatological data at the base. From 1952 through 1997, the annual rainfall at the airfield ranged from 4.00 inches to 28.40 inches, with an average of 14.16 inches. During California's most recent drought period (1984 through 1990), the annual rainfall at the Vandenberg AFB airfield averaged 9.93 inches. In 1995, 1996, 1998, and 1999, Vandenberg AFB received greater than average precipitation.

The average annual temperature, based on 1952 to 1997 Vandenberg AFB airfield data, is 57°F. Recorded low and high temperature extremes from 1952 through 1999 are 25°F and 100°F, respectively.

Spring, summer, and fall are characterized by northwesterly winds with speeds averaging 5 to 7 knots (6 to 9 miles per hour [mph]). During November, December, and January, the prevailing winds are from the east-southeast at speeds averaging 6 knots (7 mph).

C.1.3 Facility History

The site of Vandenberg AFB was first operated as a military installation (Camp Cooke Army Base) in 1941. From 1942 until the end of World War II, armored, infantry, and air force divisions trained there. A prisoner-of-war camp operated at Camp Cooke during World War II as well. Camp Cooke was deactivated in 1946 and most of the base was leased for agricultural purposes. During the Korean conflict, the camp was reactivated until 1953.

In 1956, the Department of Defense selected Camp Cook as the site of the first Air Force missile base in the United States. In 1957, North Camp Cooke was transferred to the Air Force and designated Cooke AFB. The southern portion of the Army Base was assigned to the Navy and designated Point Arguello Naval Missile Facility. In 1958, Cooke AFB was renamed Vandenberg AFB. In 1964, the Point Arguello Naval Missile Facility was transferred to the Air Force.

C.1.4 Site-Specific Descriptions

Site 32 Cluster is located on San Antonio Terrace in the northern part of Vandenberg AFB between El Rancho Road and El Rancho Oeste Road, approximately 6 miles north of the main cantonment area (Figure 2.1). The city of Lompoc (population 37,649) is 13 miles southeast of the site and the city of Santa Maria (population of 70,811) is 8 miles north of the site.

Site 32 and Site 35 are treated as a "site cluster" due to their shared biologic, geologic, and hydrogeologic settings; as well as their similar designs and linked operational history. The two sites share a common boundary composed of sections of Astral Road and Astro Road (unpaved section). Both sites were constructed and used for launching Atlas missiles.

Site 32 facilities include one missile silo, a control center, a former waste disposal area, and three drainage channels for directing storm water (designated here as Channels 32A, 32B, and 32C). A chain-link fence topped with barbed wire encloses the silo compound. The waste disposal area is primarily composed of crushed Sisquoc Formation shale bedrock excavated during construction of the silos at the Site 32 Cluster.

Site 35 facilities include a missile silo, a control center, an instrument building, and a utility building. A barbed-wire fence surrounds the site facilities. Four concrete-lined drainage channels (designated here as Channels 35A, 35B, 35C, and 35D) and one unlined channel direct runoff away from the silo facility and control center.

Raytheon used Site 32 as an active radar facility through September 1999. Future plans for Site 32 are unclear at this time; however, this site may be used as an active facility. Current uses of Site 35 include equipment storage and office work. Planned use of the land surrounding Sites 32 and 35 includes open space and grazing pastureland for cattle.

Two Atlas missiles were launched from the Site 32 facility. The Atlas missiles were fueled with a combination of Rocket Propellant No.1 (a petroleum hydrocarbon–based fuel similar to kerosene) and liquid oxygen (LOX) and did not use hydrazine as a fuel source. These Atlas launches occurred in 1963 and 1964. Dames and Moore (1993) and U.S. Air Force (1993b) reports indicate that Atlas F missiles and dry pad technology were used during launches from Site 32. The silo facility at Site 32 served primarily as a training facility for actual operations at Site 35.

Seven Atlas missiles were launched from the Site 35 facility. These launches occurred in 1962, 1963, 1964, and 1965. Battelle (1986), Dames & Moore (1993), and U.S. Air Force (1993b) indicate the silo facility was an Atlas F facility and therefore used "dry pad" technology for launches

Dry pad launch facilities typically generated wastes during missile launches, such as trichloroethene (TCE), mixed solvents, lubrication oils, and hydraulic fluids (Reynolds, Smith, and Hills, Inc. 1985). These types of wastes were likely generated at Sites 32 and 35. Launches are not currently conducted at either site and are not planned in the future.

C.2 TRAINING / MEDICAL SURVEILLANCE REQUIREMENTS

Before performing any site work, all on-site personnel, including subcontractors, will have completed the medical surveillance and training requirements specified by the Tetra Tech Health and Safety Manual, Volume II, document control numbers 3-1/3-2, and 29 CFR 1910.120. At least one team member on-site must be certified in first aid and cardiopulmonary resuscitation (CPR). Before starting any work, each on-site person will acknowledge that he/she has read, understands, and will comply with the requirements of this plan, by signing the Site Safety Plan Consent Agreement (Attachment A).

A daily tailgate health and safety meeting will be conducted before personnel sign the Daily Tailgate Safety Meeting Form, enter the site, and begin field work. This documentation will be submitted to the Project Manager/Site Safety Coordinator at the end of each field day.

This site-specific health and safety plan is a certification of Hazard Assessment.

C.3 EMERGENCY INFORMATION AND HEALTH AND SAFETY PERSONNEL

The location of Site 32 Cluster and the Lompoc Hospital are shown on Figure 7.3-1. A first aid kit, eyewash, and fire extinguisher will be available during field operations. A cellular phone must be available on-site. Table C.3-1 provides emergency contact information.

Table C.3-1
Emergency Resource Information

Local/Site Resources	Name	Phone
Police	VAFB Security	911/cell phone: 805-606-3911
Ambulance	VAFB Emergency	911/cell phone: 805-734-4117
Fire	VAFB Fire Emergency	911/cell phone: 805-734-4117
Division Health and Safety Manager	Chris McClain	626-351-4664 x 332
Project Health and Safety Manager	Jennifer Harting	805-681-3100 x 114
Site Health and Safety Officer	Matt Peterson	805-681-3100 x 112
Alternate Health and Safety Manager		
Site Phone (emergency)		
Medical Advisor/Client Rep.	Work Care	800-455-6155
Poison Information		800-764-7661
CHEMTREC		800-424-9300
Center for Disease Control		404-639-3534
National Response Center		800-424-8802
HAZMAT Spill Response Team Beeper		805-169-1035
Other(s)(HAZMAT Response)	Joe Parker, A.J. Diani	805-925-9533

C.3.1 Key Personnel

Division Health and Safety Manager: Chris McClain is responsible for overseeing Health and Safety Programs for the Tetra Tech organization. Ms. McClain can be reached at (626) 351-4664, extension 528.

Project Health and Safety Manager: Jennifer Harting is responsible for maintaining this plan, advising field staff on implementation of this plan, and conducting periodic inspections for compliance with this plan. Ms. Harting can be reached at (805) 681-3100, extension 114.

Site Health and Safety Officer: Matt Peterson, or his designee, is responsible for field coordination of Health and Safety Programs and for implementation of the Health and Safety Plan at the site. This includes ensuring the proper use of personal protective equipment (PPE), enforcing safe work habits, and conducting a tailgate safety meeting before the start of field activities. These responsibilities also include conducting periodic safety inspections of all protective gear. Mr. Peterson can be reached in the office at (805) 681-3100, extension 112, and in the field by cellular phone at 805-455-5064.

Any member of the field crew is authorized to shut down the field operation based on any expressed concern until project management can be consulted.

C.3.2 Emergency Contingency Plans

In preparing for emergencies, each site worker will know where to get first aid, a fire extinguisher, a portable eye washer, the nearest telephone, and generally what to do in case of an emergency. Subcontractors are required to provide their own first aid kit. The map to the hospital will be attached to this Health and Safety Plan Addendum and prominently displayed on the dashboard of the Tetra Tech field vehicle after the tailgate safety meeting.

If the Site Health and Safety Officer deems the site unsafe for any reason, then personnel will evacuate the exclusion and contamination reduction zones and reconvene in the designated place of refuge Emergency alerting will be conducted by voice or sign language and personnel will respond verbally or using sign language. If sign language is to be used, it will be reviewed during the tailgate safety meeting each day before starting work Evacuation will be conducted by turning off power to equipment, decontaminating workers, and calmly leaving the work site The place of refuge while performing field activities will be designated daily depending on the location of field work activities for the day. This location should be approximately 500 feet upwind of the exclusion and contamination reduction zones.

If an injury occurs, work will stop and heavy equipment will be turned off The injured person will undergo decontamination to the extent necessary to ensure their safety and the safety of the rescue personnel, and first aid will be administered. If injuries require medical attention, the following steps will be implemented:

- Step 1 Call ambulance (land line 911/cell phone: 734-4117) or go to hospital first
- Step 2 Call Tetra Tech office. Notify Kevin McNamara or Jennifer Harting at (805) 681-3100, extensions 134 and 114, respectively.
- Step 3 Give the following information to Mr. McNamara or Ms. Harting:

  a Injury sustained;

  b. Location of the accident;

  c. Personnel involved; and

  d. Who has been contacted and what action has been taken (e.g., ambulance, hospital).

The nearest medical facility is Lompoc District Hospital, up to 45 minutes away. A map to the hospital is attached (Figure C.3-1). The hospital is located at 508 E. Hickory Avenue, on the corner of Hickory Avenue and D Street in Lompoc, California.

C.4 HAZARDS OF CONCERN

C.4.1 Chemical Hazards

Refer to Table 7.4-1 for a list of potential contaminants that may be encountered in soil or groundwater. Table 7.4-2 summarizes threshold limits including Short Term Exposure Limits (STELs) and Permissible Exposure Limits (PELs), where available for the potential site contaminants. The RI/FS Health and Safety Plan (JEG 1993b) provide additional chemical hazard information for many of the contaminants that may be encountered. Chemical hazard information is provided in Attachment C.

The chemical hazard information includes safe handling procedures, permissible exposure limits, and upper explosive limits for potential site contaminants.

C.4.2 Physical Hazards

The RI/FS Health and Safety Plan (JEG 1993b) and the Tetra Tech Corporate Health and Safety Manual (Tetra Tech 1999) provide additional information regarding safety procedures with respect to physical hazards in the field. Drilling, sampling, and phytoremediation hazards may include, but are not necessarily limited to:

- Moving equipment parts;
- Noise from equipment;
- Lifting and carrying heavy equipment;
- Oral or dermal contact with potentially contaminated soils;
- Inhalation of potentially contaminated dust generated during drilling;
- Contact with poisonous plants (e.g., poison oak), animals (e.g., rattlesnakes), or insects;
- Slips, trips, and falls from uneven terrain;
- On-site vehicular traffic in populated areas;
- Physical distress related to heat or cold; and
- Extreme weather conditions (e.g., lightning or wind).

To avoid injury from moving equipment parts, personnel will be properly trained before using sampling equipment. Personnel will obtain help from co-workers when heavy lifting is required. To avoid contact with contaminated soil, personnel will wear appropriate PPE. Personnel will exercise extreme caution when working in areas where poison oak, snakes, or uneven terrain are present. The best protection against poison oak is PPE, such as Tyvek (taped to boots and gloves), rubber boots, and inner and outer gloves. Whenever lightning is within 3 miles, site activities will be shut down. Physical hazards related to heat and cold are discussed below.

Hazards associated with drilling, IDW management, phytoremediation, and injection of vegetable oil include noise and heavy equipment in addition to the ones listed above. Care will be taken to avoid the bucket of the front loader. Personnel will not walk behind any heavy equipment without first notifying the equipment operator. Workers in close proximity will maintain visual contact with equipment operator at all times. Hearing protection is required around noisy equipment. Dusts will be mitigated by spraying water on the dry soil. Non-essential personnel must remain in the support zone. For a more detailed list of heavy equipment hazards, see Use of Heavy Equipment, Safe Work Practice 6-26 in the Tetra Tech Corporate Health and Safety Manual (Tetra Tech 1999).

Hazards associated with contacting site soil result mostly from dermal absorption, ingestion, and inhalation of dusts. Personnel will wear PPE (e.g. Tyvek, gloves, safety glasses) when exposure to contaminants of concern is possible during drilling, phytoremediation, and IDW soil management field work activities. Non-essential personnel will not handle soil and will stay in the support zone.

C.4.2.1 Heat Stress

Wearing PPE during warm weather puts employees at considerable risk of developing heat-related illness. Health effects from heat stress range from transient heat fatigue or rashes to serious illness (e.g., heat stroke) or death. Employees are instructed to recognize and treat heat-related illness during 8-hour health and safety refresher and first aid training courses. When working in hot environments, the following procedures will be implemented to reduce the risk of heat stress:

- Follow the buddy system and watch for signs of heat stress in co-workers;
- Implement work and rest cycles, as appropriate, to periodically allow employees to remove protective clothing and cool down;
- Regularly drink liquids to replace lost body fluids; and
- Uses cooling devices such as shade canopies, sun hats, ice vests, or fans, if necessary.

Procedures for treating heat stress conditions and for monitoring heat stress are described in Volume III of the Tetra Tech Health and Safety Manual (Tetra Tech 1999).

C.4.2.2 Cold Exposure

Bare flesh and body extremities such as fingers, toes, and ears are most susceptible to wind chill or extremely low ambient temperatures. Employees are instructed to recognize and treat cold-related injuries during 8-hour health and safety refresher and first aid training courses. The two primary factors influencing the risk potential for cold stress are temperature and wind velocity. Wetness can also contribute to cold stress. Hypothermia can occur at temperatures above freezing if the individual is wearing wet or damp clothing. When working in cold environments, the following procedures will be implemented to lessen the chances of cold-related injuries:

- Protect exposed skin surfaces with appropriate insulating clothing such as face masks, gloves, and footwear;
- Dress in layers to adapt to changing temperatures;
- Provide extra insulating clothing on-site;
- Reduce the duration of exposure to cold; and
- Change wet or damp clothing as soon as possible.

Procedures for evaluating the combined effect of temperatures and wind are described in Volume III of the Tetra Tech Health and Safety Manual (Tetra Tech 1999).

C.5 AIR MONITORING

Air monitoring will be conducted at the Site 32 Cluster to ensure worker safety during drilling, phytoremediation, vegetable oil injection, and groundwater sampling activities. A Photoionization Detector (PID) will be used for organic vapor screening. Personnel will measure for organic vapors in the breathing zone with a PID a minimum of every half-hour during drilling or digging associated with phytoremediation activities. Personnel will measure organic vapor concentrations at the Site 32 Cluster in the breathing zone and record the results in the logbook.

If the PID reading is 5 parts per million (ppm) or more above background, personnel will allow the area to vent for a few minutes and then take another PID reading. Personnel will put on full-face respirators with organic vapor/acid gas cartridges and P100 filters (respiratory level C) if readings are more than 5 ppm above background in the breathing zone

If PID readings are consistently 25 ppm or more above background in the breathing zone, then personnel will retreat to the support zone. Work will resume only after completion of a site-specific health and safety plan that addresses use of Level B PPE

C.6 WORK ZONES

A minimum of three work zones (exclusion zone, contamination reduction zone, and support zone) will normally be established to ensure that:

- All personnel are properly protected against existing site hazards;
- Work activities and contaminants are confined to appropriate areas;
- Personnel can be controlled and evacuated in the event of an emergency;
- Potential routes and levels of possible contaminant dispersion can be evaluated; and
- Movement of personnel and equipment across these zones shall be minimized and restricted to specified areas and specific control points to prevent cross-contamination.

These zones will be delineated daily during the tailgate health and safety meeting, when necessary.

C.6.1 Exclusion Zone

Sampling personnel will establish an exclusion zone that is a 20-foot radius around the immediate drilling/injection/sampling and sampling equipment staging area. Because the Site 32 Cluster is located in a remote area, the exclusion zone may not require delineation with caution tape.

Equipment and PPE shall be cleaned of gross contamination prior to exiting the exclusion zone and entering the contamination reduction zone.

C.6.2 Contamination Reduction Zone

The contamination reduction zone is a transition area between the exclusion zone and support zone or clean area. Final decontamination operations are performed in the contamination reduction zone prior to entry to the support zone. The contamination control line separates the contamination reduction zone from the support zone.

C.6.3 Support Zone

The support zone is an uncontaminated or clean zone where workers should <u>not</u> be exposed to hazardous conditions. Typical activities included in this zone consist of:

- Interfacing with field teams, clients, and regulators;
- Eating and drinking; and
- Maintaining site security, PPE, supplies, and work vehicles

Site visitors must remain in the support zone unless they obtain specific permission from the site safety officer to enter the contamination reduction zone or the exclusion zone Appropriate PPE must be put on before such an entry is made.

C.7 PERSONAL PROTECTIVE EQUIPMENT

C.7.1 General

Selection of the appropriate PPE is required before work can begin. Key factors involved in this process are identifying known and suspected hazards or routes of entry, and effectiveness of the PPE in providing a barrier to these hazards. Appendix B to 29 CFR 1910.120 "General Description and Discussion of the Levels of Protection and Protective Gear" offers guidance regarding the specification and application of PPE. The PPE prescribed in the plan is based on this guidance.

Personal protective equipment is divided into four categories based on the amount of protection it provides. Level A is the highest level of protection and Level D is the lowest. Level D will be the most likely protection level used during the drilling, vegetable oil injection, phytoremediation, and groundwater sampling activities. Levels A and B require self-contained breathing apparatus or supplied air. Level C requires air-purifying respirators. If vapor concentrations in the breathing zone are 5 ppm or more above background, Level C protection will be required. Levels A and B are neither anticipated nor permissible under this project-specific Health and Safety Plan. If organic vapor concentrations measured with a PID are more than 25 ppm above background, requiring Level B protection, the work will immediately be stopped. The Project Health and Safety Manager will then be informed, approve use of Level B protection, and write a site-specific health and safety plan that addresses use of Level B PPE before work can be resumed at the site.

C.7.2 Minimum PPE

C.7.2.1 Minimum PPE for Drilling Activities

The level of protection prescribed under this plan is Level D. All personnel performing field work, including subcontractors will use Level D protection. This protection will include, as a minimum:

- Work apparel appropriate for the task to be performed. This generally means a sleeved shirt and long pants;
- Steel-toed boots;
- Safety glasses or goggles (ANSI § 87.1);
- Hard hats when overhead hazards are present and in hard hat designated areas;
- Nitrile gloves for handling potentially contaminated materials;

- A disposable dust mask or respirator with a minimum of a P100 filter during site work conditions when dust is present; and

- A respirator with an organic vapor/acid gas cartridge and a P100 filter during site work where organic vapors exceed the action level (5 ppm) but are less than 25 ppm.

When direct contact with contaminated soil is likely, disposable coveralls such as Tyvek, gloves, and safety glasses will be worn during drilling and sampling operations.

Visitors may use modified Level D without gloves as long as they remain in the support zone.

C.7.2.2 Minimum PPE for Vegetable Oil Injection Activities

Subcontractors and personnel may come in contact with vegetable oil that is heated to 100 degrees Fahrenheit before it is injected into the test wells. When direct contact with the heated fluid is likely, the minimum PPE required is:

- Chemical resistant splash apron;

- Water-resistant work apparel appropriate for the task to be performed;

- Steel-toed rubber boots;

- Safety face shield;

- Hard hats (when overhead hazards are possible); and

- Heat resistant nitrile outer gloves.

C.7.2.3 Minimum PPE for Phytoremediation Activities

The level of protection prescribed under this plan is Level D. All personnel performing field work, including subcontractors will use Level D protection. This protection will include, as a minimum:

- Work apparel appropriate for the task to be performed. This generally means a sleeved shirt and long pants;

- Steel-toed boots;

- Safety glasses or goggles (ANSI § 87.1);

- Hard hats when overhead hazards are present and in hard hat designated areas;

- Nitrile gloves for handling potentially contaminated materials;

- A disposable dust mask or respirator with a minimum of a P100 filter during site work conditions when dust is present; and

- A respirator with an organic vapor/acid gas cartridge and a P100 filter during site work where organic vapors exceed the action level (5 ppm) but are less than 25 ppm.

When direct contact with contaminated soil is likely, disposable coveralls such as Tyvek, gloves, and safety glasses will be worn during drilling and sampling operations

Visitors may use modified Level D without gloves as long as they remain in the support zone

C.7.4 Upgraded PPE

The level of protection will be upgraded from Level D to Level C when respiratory hazards of dust or organic vapors require this action. When monitoring equipment indicates elevated organic vapors in the work area, the Site Health and Safety Manager and his/her designee will take immediate action to:

- Warn the workers of this condition;
- Stop work if an action level has been reached or exceeded; and
- Decide to either upgrade PPE and continue work or stop work altogether if work cannot continue in a safe manner.

The PPE will then be upgraded to address the new condition. The readings from monitoring equipment and actions taken will be documented.

C.7.5 PPE requirements

The chart below is a simplified description of the PPE requirement. The default PPE specification is Level D.

LEVEL C	***Modified Level C - no skin hazards***	***Standard Level C- skin hazards present***
Respiratory hazards present	• Air-purifying respirator, full face • Modified Level D equipment	• Air-purifying respirator, full face, for organic vapor hazards • All standard Level D equipment
LEVEL D	***Modified Level D - no skin hazards***	***Standard Level D- skin hazards present***
No respiratory hazards	• Long pants, sleeved shirt • Steel-toed boots • Safety glasses • Nitrile outer gloves with liner • Hard hat, when appropriate	• Chemical resistant coveralls, e.g., Tyvek • Steel-toed boots • Safety glasses • Nitrile outer gloves with liner • Hard hat, when appropriate

C.8 DECONTAMINATION

C.8.1 Personal Protective Equipment

Disposable PPE will be changed daily, decontaminated with Alconox soap and water, and placed in the domestic trash. Gross contamination on PPE, including boots, will be removed in the exclusion zone using and decontaminated with Alconox soap and water. PPE will be final-cleaned and removed in the contamination reduction zone.

C.8.2 Equipment and Materials

Tools, sampling equipment, and other related materials will be decontaminated in the exclusion zone. Decontamination will consist of scrubbing equipment with a brush and potable water and Alconox solution until all visible contamination is removed, and rinsing twice with potable water. Equipment will be additionally rinsed with Type II reagent water when it will be used for sampling. Heavy equipment will be cleaned of gross contamination in the exclusion zone and thoroughly decontaminated with soap and water at the central staging area. The central staging area will be located along the western portion of El Rancho Oeste Road.

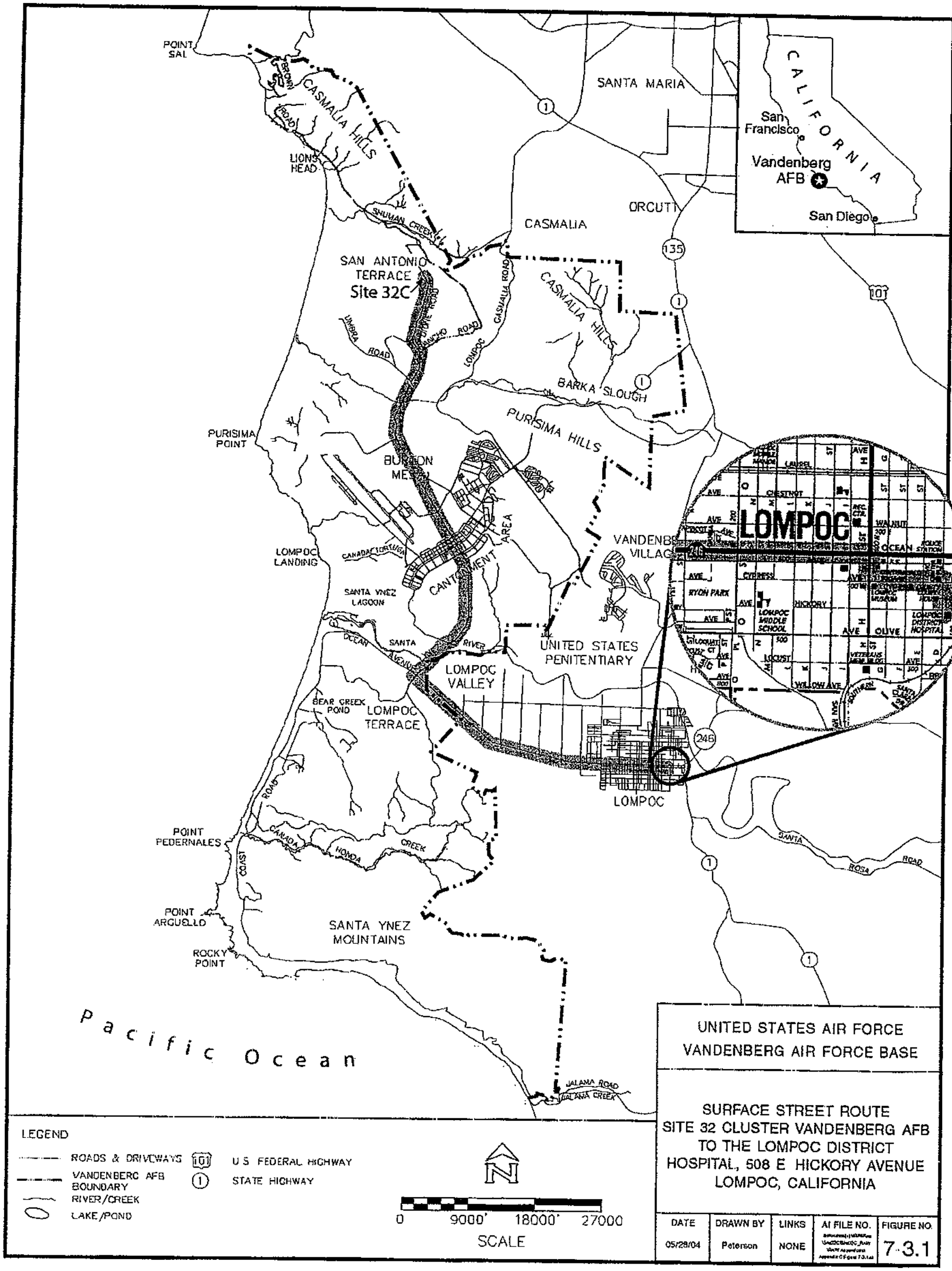
C.8.3 Decontamination Solutions

Decontamination water will be stored in a portable tank and transported to a holding tank at the Agena Tank Farm. The holding tank will be sampled at the Agena Tank Farm and analyzed for contaminants of concern. Based on analytical results, decontamination solutions will be disposed of appropriately.

C.8.4 Personal Hygiene

All on-site personnel will maintain good hygiene practices. On-site personnel will wash hands and face immediately upon completion of site activities. Smoking, eating, and drinking are allowed only in the support zone. Personnel must wash their hands and face before smoking, eating, or drinking.

FIGURES



UNITED STATES AIR FORCE
VANDENBERG AIR FORCE BASE

SURFACE STREET ROUTE
SITE 32 CLUSTER VANDENBERG AFB
TO THE LOMPOC DISTRICT
HOSPITAL, 508 E HICKORY AVENUE
LOMPOC, CALIFORNIA

DATE	DRAWN BY	LINKS	AI FILE NO.	FIGURE NO.
05/28/04	Peterson	NONE	[illegible]	7-3.1

TABLES

Table 7.4-1
Potential Contaiminants of Exposure
IRP Site 32 Cluster (Missile Silo 576-D and G) IRA Area
Vandenberg AFB, California

IRP Site 32 Cluster IRA Area	Chemicals of Concern
Soil	
Missile Silo 576-D and G	• Di-n-butyl phthalate • trichloroethene • cis-1,2- Dichloroethene • trans-1,2- Dichloroethene • Metals
Groundwater	
Missile Silo 576-D and G	• trichloroethene • cis-1,2- Dichloroethene • trans-1,2- Dichloroethene • vinyl chloride •Metals

Table 7.4-2
Contaminants of Concern with Threshold Limit Values and Permissible Exposure Levels
IRP Site 32 Cluster
Vandenberg AFB, California

Contaminant of Concern	Form	PEL[1]		STEL[1]	
Arsenic	Arsenic and inorganic arsenic compounds	0.01	mg/m^3	N/A	
Cadmium	Metal dust	0.005	mg/m^3	N/A	
	Soluble salts	0.005	mg/m^3	N/A	
Cobalt	Metal fumes and dust	0.02	mg/m^3	N/A	
Copper	Metal fumes	0.01	mg/m^3	N/A	
	Salts, dust, and mist	1	mg/m^3	N/A	
Iron	Soluble iron salts	1.0	mg/m^3	N/A	
Lead	Dust and fume	0.05	mg/m^3	N/A	
Manganese	Manganese and compounds as Mn	0.2	mg/m^3	N/A	
Magnesium	Magnesium oxide fume	10.0	mg/m^3	3	mg/m^3
Mercury	Alkyls as Hg	0.01	mg/m^3	0.03	mg/m^3
	As vapor	0.05	mg/m^3	N/A	
	Inorganic compounds	0.01	mg/m^3	N/A	
Molybdenum	Metal, insoluble	10.0	mg/m^3	N/A	
	Soluble compounds	5	mg/m^3	N/A	
Nickel	Insoluble	1	mg/m^3	N/A	
	Soluble	0.1	mg/m^3	N/A	
Selenium	Selenium compounds as Se	0.2	mg/m^3	N/A	
Thallium	Soluble compounds as Tl	0.1	mg/m^3	N/A	
Zinc	Fumes	5.0	mg/m^3	N/A	
	Dust	10.0	mg/m^3	N/A	
1,1-Dichloroethene		1	ppm	N/A	
cis-1,2-Dichloroethene		200	ppm	N/A	
trans-1,2-Dichloroethene		200	ppm	N/A	
1,1,1-Trichloroethane		350	mg/m^3	450	ppm
Trichloroethene		25	ppm	100	ppm
Vinyl chloride		1	ppm	N/A	

Definitions:

mg/m^3 - milligrams per cubic meter
N/A - not applicable
ppm - parts per million
STEL - Short Term Exposure Limit
PEL - Permissible Exposure Limit

Note:

1 - California Code of Regulations, Title 8, Section 5155 Airborne Contaminants

ATTACHMENTS

ATTACHMENT A

SITE SAFETY PLAN APPROVAL SHEET

I have reviewed and hereby approve of this Tetra Tech, Inc., Site Specific Health and Safety Plan for the Site 32 Cluster Interim Removal Action. This Health and Safety Plan has been written for the exclusive use of Tetra Tech, Inc., its employees and subcontractors. Tetra Tech Inc. claims no responsibility for its use by others. This plan is written for the specific site conditions, dates, and listed personnel. Should these conditions change, this plan will be amended accordingly.

PROJECT MANAGER: ______________________

Title: ______________________

Signature: ______________________ **Dated:** ______________

PLAN PREPARED BY: Matt Peterson

Title: Scientist III

Signature: MP **Dated:** 6/7/04

APPROVED BY: ______________________

Title: ______________________

Signature: ______________________ **Dated:** ______________

Tetra Tech, Inc.

ATTACHMENT B

SITE SAFETY PLAN CONSENT AGREEMENT

I have reviewed the Tetra Tech, Inc., Site Safety Plan for Site 32 Cluster Interim Removal Action. I understand its contents and purpose and consent to adhere to its policies, procedures, and guidelines while an employee of Tetra Tech or its subcontractors.

Employee Name (Print)	Employee (Signature)	Company (Print)	Date

Tetra Tech, Inc.

ATTACHMENT C

MSDS SHEETS

NIOSH Pocket Guide to Chemical Hazards

Antimony	CAS 7440-36-0
Sb	RTECS CC4025000
Synonyms & Trade Names Antimony metal, Antimony powder, Stibium	**DOT ID & Guide** 1549 157 (inorganic compounds, n.o.s.) 2871 170 (powder) 3141 157 (inorganic liquid compounds, n.o.s.)

Exposure Limits	NIOSH REL*: TWA 0.5 mg/m^3 [*Note: The REL also applies to other antimony compounds (as Sb).]
	OSHA PEL*: TWA 0.5 mg/m^3 [*Note: The PEL also applies to other antimony compounds (as Sb).]

IDLH 50 mg/m^3 (as Sb) See: 7440360	**Conversion**

Physical Description
Silver-white, lustrous, hard, brittle solid; scale-like crystals; or a dark-gray, lustrous powder.

MW: 121.8	BP: 2975°F	MLT: 1166°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 6.69
FI.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but a moderate explosion hazard in the form of dust when exposed to flame.

Incompatibilities & Reactivities
Strong oxidizers, acids, halogenated acids [Note: Stibine is formed when antimony is exposed to nascent (freshly formed) hydrogen.]

Measurement Method
Filter; Acid; Flame atomic absorption spectrometry; II(4) [P&CAM #261] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: Daily	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 5 mg/m^3: (APF = 10) Any dust and mist respirator except single-use and quarter-mask respirators^/(APF = 10) Any supplied-air respirator

Up to 12.5 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/(APF = 25) Any powered, air-purifying respirator with a dust and mist filter^

Up to 25 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/(APF = 50) Any powered, air-purifying respirator with a

tight-fitting facepiece and a high-efficiency particulate filter/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece Up to 50 mg/m^3: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms irritation eyes, skin, nose, throat, mouth; cough; dizziness; headache; nausea, vomiting, diarrhea; stomach cramps; insomnia; anorexia; unable to smell properly
Target Organs Eyes, skin, respiratory system, cardiovascular system
See also: INTRODUCTION See ICSC CARD: 0775 See MEDICAL TESTS: 0016

NIOSH Pocket Guide to Chemical Hazards

Arsenic (inorganic compounds, as As)	CAS 7440-38-2 (metal)
As (metal)	**RTECS** CG0525000 (metal)
Synonyms & Trade Names Arsenic metal: Arsenia Other synonyms vary depending upon the specific As compound. [Note: OSHA considers "Inorganic Arsenic" to mean copper acetoarsenite & all inorganic compounds containing arsenic except ARSINE.]	**DOT ID & Guide** 1558 152 (metal) 1562 152 (dust)

Exposure Limits	NIOSH REL: Ca C 0.002 mg/m^3 [15-minute] See Appendix A
	OSHA PEL: [1910.1018] TWA 0.010 mg/m^3
IDLH Ca [5 mg/m^3 (as As)] See: IDLH INDEX	**Conversion**

Physical Description
Metal: Silver-gray or tin-white, brittle, odorless solid.

MW: 74.9	BP: Sublimes	MLT: 1135°F (Sublimes)	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 5.73 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame.

Incompatibilities & Reactivities
Strong oxidizers, bromine azide [Note: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.]

Measurement Method
Filter; Acid; Hydride generation atomic absorption spectrometry; IV [#7900] [Also #7300, Elements] See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin absorption, skin and/or eye contact ingestion
Symptoms Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, [Potential occupational carcinogen]
Target Organs Liver, kidneys, skin, lungs, lymphatic system **Cancer Site** [lung & lymphatic cancer]
See also: INTRODUCTION

NIOSH Pocket Guide to Chemical Hazards

Barium chloride (as Ba)	**CAS** 10361-37-2
$BaCl_2$	**RTECS** CQ8750000
Synonyms & Trade Names Barium dichloride	**DOT ID & Guide** 1564 154 (barium compounds, n.o.s.)

Exposure Limits	NIOSH REL*: TWA 0.5 mg/m^3 [*Note: The REL also applies to other soluble barium compounds (as Ba) except Barium sulfate.]
	OSHA PEL*: TWA 0.5 mg/m^3 [*Note: The PEL also applies to other soluble barium compounds (as Ba) except Barium sulfate.]

IDLH 50 mg/m^3 (as Ba) See: IDLH INDEX	**Conversion**

Physical Description
White, odorless solid.

MW: 208.2	BP: 2840°F	MLT: 1765°F	Sol: 38%
VP: Low	IP: ?		Sp.Gr: 3.86
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid

Incompatibilities & Reactivities
Acids, oxidizers

Measurement Method
Filter; Water; Flame atomic absorption spectrometry; IV [#7056, Barium, soluble cmpds] See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: Daily	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 5 mg/m^3: (APF = 10) Any dust and mist respirator except single-use and quarter-mask respirators/(APF = 10) Any supplied-air respirator

Up to 12.5 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/(APF = 25) Any powered, air-purifying respirator with a dust and mist filter

Up to 25 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 50 mg/m^3: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms irritation eyes, skin, upper respiratory system; skin burns; gastroenteritis; muscle spasm; slow pulse, extrasystoles; hypokalemia
Target Organs Eyes, skin, respiratory system, heart, central nervous system
See also: INTRODUCTION See ICSC CARD: 0614

NIOSH Pocket Guide to Chemical Hazards

Cadmium dust (as Cd)	CAS 7440-43-9 (metal)
Cd (metal)	**RTECS** EU9800000 (metal)
Synonyms & Trade Names Cadmium metal: Cadmium Other synonyms vary depending upon the specific cadmium compound.	**DOT ID & Guide** 2570 154 (compounds)

Exposure Limits	NIOSH REL*: Ca See Appendix A [*Note: The REL applies to all Cadmium compounds (as Cd).]
	OSHA PEL*: [1910.1027] TWA 0.005 mg/m^3 [*Note: The PEL applies to all Cadmium compounds (as Cd).]

IDLH Ca [9 mg/m^3 (as Cd)] See: IDLH INDEX	**Conversion**

Physical Description
Metal: Silver-white, blue-tinged lustrous, odorless solid.

MW: 112.4	BP: 1409°F	MLT: 610°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 8.65 (metal)
FI.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid in bulk form, but will burn in powder form.

Incompatibilities & Reactivities
Strong oxidizers; elemental sulfur, selenium & tellurium

Measurement Method
Filter; Acid; Flame atomic absorption spectrometry; IV [#7048] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: N.R. Eyes: N.R. Wash skin: Daily Remove: N.R. Change: Daily	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, ingestion

Symptoms pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [Potential occupational carcinogen]

Target Organs respiratory system, kidneys, prostate, blood **Cancer Site** [prostatic & lung cancer]
See also: INTRODUCTION

NIOSH Pocket Guide to Chemical Hazards

Chlordane	CAS 57-74-9
$C_{10}H_6Cl_8$	RTECS PB9800000
Synonyms & Trade Names Chlordan; Chlordano; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane	**DOT ID & Guide** 2762 131

Exposure Limits	NIOSH REL: Ca TWA 0.5 mg/m^3 [skin] See Appendix A
	OSHA PEL: TWA 0.5 mg/m^3 [skin]
IDLH Ca [100 mg/m^3] See: 57749	**Conversion**

Physical Description
Amber-colored, viscous liquid with a pungent, chlorine-like odor. [insecticide]

MW: 409.8	BP: Decomposes	FRZ: 217-228°F	Sol: 0.0001%
VP: 0.00001 mmHg	IP: ?		Sp.Gr(77°F): 1.6
FI.P: NA	UEL: NA	LEL: NA	

Noncombustible Liquid, but may be utilized in flammable solutions.

Incompatibilities & Reactivities
Strong oxidizers, alkaline reagents

Measurement Method
Filter/Chromosorb tube-102; Toluene; Gas chromatography/Electrochemical detection; IV [#5510]
See: NMAM INDEX

Personal Protection & Sanitation
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Blurred vision; confusion; ataxia, delirium; cough; abdominal pain, nausea, vomiting, diarrhea; irritability, tremor, convulsions; anuria; in animals: lung, liver, kidney damage; [Potential occupational carcinogen]

Target Organs central nervous system, eyes, lungs, liver, kidneys

Cancer Site [in animals: liver cancer]
See also: INTRODUCTION See ICSC CARD: 0740 See MEDICAL TESTS: 0042

NIOSH Pocket Guide to Chemical Hazards

Chromium metal	CAS 7440-47-3
Cr	**RTECS** GB4200000
Synonyms & Trade Names Chrome, Chromium	**DOT ID & Guide**

Exposure Limits	NIOSH REL: TWA 0.5 mg/m^3 See Appendix C
	OSHA PEL*: TWA 1 mg/m^3 See Appendix C [*Note: The PEL also applies to insoluble chromium salts.]

IDLH 250 mg/m^3 (as Cr) See: 7440473	**Conversion**

Physical Description
Blue-white to steel-gray, lustrous, brittle, hard, odorless solid.

MW: 52.0	BP: 4788°F	MLT: 3452°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 7.14
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but finely divided dust burns rapidly if heated in a flame.

Incompatibilities & Reactivities
Strong oxidizers (such as hydrogen peroxide), alkalis

Measurement Method
Filter; Acid; Flame atomic absorption spectrometry; IV [#7024] See: NMAM INDEX

Personal Protection & Sanitation Skin: N.R. Eyes: N.R. Wash skin: N.R. Remove: N.R. Change: N.R.	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH

Up to 2.5 mg/m^3: (APF = 5) Any dust and mist respirator*

Up to 5 mg/m^3: (APF = 10) Any dust and mist respirator except single-use and quarter-mask respirators*/(APF = 10) Any supplied-air respirator*

Up to 12.5 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode*/(APF = 25) Any powered, air-purifying respirator with a dust and mist filter*

Up to 25 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 250 mg/m^3: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination

with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms irritation eyes, skin; lung fibrosis (histologic)
Target Organs Eyes, skin, respiratory system
See also: INTRODUCTION See ICSC CARD: 0029 See MEDICAL TESTS: 0052

NIOSH Pocket Guide to Chemical Hazards

Cobalt metal dust and fume (as Co)	CAS 7440-48-4
Co	RTECS GF8750000
Synonyms & Trade Names Cobalt metal dust, Cobalt metal fume	**DOT ID & Guide**

Exposure Limits	NIOSH REL: TWA 0.05 mg/m^3
	OSHA PEL†: TWA 0.1 mg/m^3

IDLH 20 mg/m^3 (as Co) See: 7440484	**Conversion**

Physical Description
Odorless, silver-gray to black solid.

MW: 58.9	BP: 5612°F	MLT: 2719°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 8.92
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but finely divided dust will burn at high temperatures.

Incompatibilities & Reactivities
Strong oxidizers, ammonium nitrate

Measurement Method
Filter; Acid; Flame atomic absorption spectrometry; IV [#7027] [Also #7300, Elements] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: Prevent skin contact Eyes: N.R. Wash skin: When contaminated Remove: When wet or contaminated Change: Daily	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH

Up to 0.25 mg/m^3: (APF = 5) Any dust and mist respirator^

Up to 0.5 mg/m^3: (APF = 10) Any dust and mist respirator except single-use and quarter-mask respirators*^/(APF = 10) Any dust, mist, and fume respirator*/(APF = 10) Any supplied-air respirator*

Up to 1.25 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode*/(APF = 25) Any powered, air-purifying respirator with a dust and mist filter*^/(APF = 25) Any powered, air-purifying respirator with a dust, mist, and fume filter*

Up to 2.5 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 20 mg/m^3: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full

facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms Cough, dyspnea (breathing difficulty), wheezing, decreased pulmonary function; weight loss; dermatitis; diffuse nodular fibrosis; respiratory hypersensitivity, asthma
Target Organs Skin, respiratory system
See also: INTRODUCTION See ICSC CARD: 0782 See MEDICAL TESTS: 0055

NIOSH Pocket Guide to Chemical Hazards

Copper (dusts and mists, as Cu)	CAS 7440-50-8
Cu	**RTECS** GL5325000
Synonyms & Trade Names Copper metal dusts, Copper metal fumes	**DOT ID & Guide**

Exposure Limits	NIOSH REL*: TWA 1 mg/m^3 [*Note: The REL also applies to other copper compounds (as Cu) except Copper fume.]
	OSHA PEL*: TWA 1 mg/m^3 [*Note: The PEL also applies to other copper compounds (as Cu) except copper fume]

IDLH 100 mg/m^3 (as Cu) See: 7440508	**Conversion**

Physical Description
Reddish, lustrous, malleable, odorless solid.

MW: 63.5	BP: 4703°F	MLT: 1981°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 8 94
FI.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form, but powdered form may ignite.

Incompatibilities & Reactivities
Oxidizers, alkalis, sodium azide, acetylene

Measurement Method
Filter; Acid; Flame atomic absorption spectrometry; IV [#7029] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: Daily	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 5 mg/m^3: (APF = 5) Any dust and mist respirator*

Up to 10 mg/m^3: (APF = 10) Any dust and mist respirator except single-use and quarter-mask respirators*^/(APF = 10) Any supplied-air respirator*

Up to 25 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode*/ (APF = 25) Any powered, air-purifying respirator with a dust and mist filter*

Up to 50 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 100 mg/m^3: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full

facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms irritation eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis; in animals: lung, liver, kidney damage; anemia
Target Organs Eyes, skin, respiratory system, liver, kidneys (increase(d) risk with Wilson's disease)
See also: INTRODUCTION See ICSC CARD: 0240 See MEDICAL TESTS: 0057

NTP CHEMICAL REPOSITORY (RADIAN CORPORATION, AUGUST 29, 1991)
P,P'-DDE

-IDENTIFIERS

*CATALOG ID NUMBER: 000453
*CAS NUMBER: 72-55-9
*BASE CHEMICAL NAME: DDE,P,P'-
*PRIMARY NAME: P,P'-DDE
*CHEMICAL FORMULA: C14H8Cl4
*STRUCTURAL FORMULA: (ClC6H4)2C=CCl2
*WLN: GYGUYR XG&R XG
*SYNONYMS:
2,2-BIS(P-CHLOROPHENYL)-1,1-DICHLOROETHENE
2,2-BIS(4-CHLOROPHENYL)-1,1-DICHLOROETHENE
2,2-BIS(P-CHLOROPHENYL)-1,1-DICHLOROETHYLENE
2,2-BIS(4-CHLOROPHENYL)-1,1-DICHLOROETHYLENE
DDE
DDT DEHYDROCHLORIDE
1,1'-DICHLOROETHENYLIDENE)BIS(4-CHLOROBENZENE)
P,P'-DICHLORODIPHENYL DICHLOROETHYLENE
DICHLORODIPHENYLDICHLOROETHYLENE
4,4'-DDE
1,1-DICHLORO-2,2-BIS(P-CHLOROPHENYL)ETHYLENE
NCI-C00555

-PHYSICAL CHEMICAL DATA

*PHYSICAL DESCRIPTION: LITERATURE: White crystalline solid
REPOSITORY: White powder
*MOLECULAR WEIGHT: 318.03
*SPECIFIC GRAVITY: Not available
*DENSITY: Not available
*MP (DEG C): 88-90 C [269,275]
*BP (DEG C): 316.5 C [025]
*SOLUBILITIES:
WATER : <0.1 mg/mL @ 22 C (RAD)
DMSO : 50-100 mg/mL @ 21 C (RAD)
95% ETHANOL : 10-50 mg/mL @ 21 C (RAD)
METHANOL : Not available
ACETONE : 50-100 mg/mL @ 21 C (RAD)
TOLUENE : Not available
OTHER SOLVENTS:
Fats: Soluble [395]
Most organic solvents: Soluble [395]
*VOLATILITY:
Vapor pressure: Not available
Vapor density : Not available
*FLAMMABILITY(FLASH POINT):
Flash point data for this chemical are not available. It is probably combustible. Fires involving this material can be controlled with a dry chemical, carbon dioxide or Halon extinguisher.
*UEL: Not available LEL: Not available
*REACTIVITY:
This compound is incompatible with strong oxidizing agents and strong bases [269]. Oxidation is catalyzed by UV radiation [395].
*STABILITY:
This chemical is sensitive to exposure to light. Solutions of this chemical in water, DMSO, 95% ethanol or acetone should be stable for 24 hours under normal lab conditions (RAD).
*OTHER PHYSICAL DATA:
Adsorption capacity: 232 mg/g

-TOXICITY

*NIOSH REGISTRY NUMBER: KV9450000

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*TOXICITY:
   typ. dose        mode      specie      amount        unit       other
      LD50           orl         rat        880         mg/kg
*AQTX/TLM96: Not available
*SAX TOXICITY EVALUATION:
  THR: An experimental carcinogen and neoplastigen.  MODERATE via oral route.
       MUTATION data.
*CARCINOGENICITY:
  Tumorigenic Data:
    TDLo: orl-mus  9700 mg/kg/78W-C
    TDLo: orl-ham    36 gm/kg/86W-C
    TD  : orl-mus    28 gm/kg/80W-C
    TD  : orl-mus    17 gm/kg/78W-C
    TD  : orl-ham    57 gm/kg/68W-C
    TD  : orl-ham    41 gm/kg/97W-C
    TD  : orl-ham    81 gm/kg/97W-C
  Status: NCI Carcinogenesis Bioassay (Feed); Negative: Male and Female Rat
           [620]
          NCI Carcinogenesis Bioassay (Feed); Positive: Male and Female Mouse
           [620]
*MUTATION DATA:
       test            lowest dose       |       test          lowest dose
   ------------    -----------------     |   ------------   ----------------
    sln-dmg-orl          1 pph           |   dnd-rat:lvr       300 umol/L
    cyt-rat:oth         10 ug/L          |   otr-mus:emb     42600 nmol/L
    dni-mus-orl         50 mg/kg         |   msc-mus:lym        40 mg/L/4H
    msc-ham:ovr         20 mg/L          |
*TERATOGENICITY:
  Reproductive Effects Data:
    TDLo: ipr-rat  3500 ug/kg (7D pre)
*STANDARDS, REGULATIONS & RECOMMENDATIONS:
  OSHA: None
  ACGIH: None
  NIOSH Criteria Document: None
  NFPA Hazard Rating: Health (H): None
                      Flammability (F): None
                      Reactivity (R): None
*OTHER TOXICITY DATA:
  Review: Toxicology Review
  Status: EPA Genetox Program 1986, Positive: In vitro cytogenetics-nonhuman
          EPA Genetox Program 1986, Positive: V79 cell culture-gene mutation
          EPA Genetox Program 1986, Positive/limited: Carcinogenicity-mouse/rat
          EPA Genetox Program 1986, Weakly positive: L5178Y cells in vitro-TK
           test
          EPA Genetox Program 1986, Negative: Host-mediated assay; Histidine
           reversion-Ames test
          EPA Genetox Program 1986, Negative: S cerevisiae-homozygosis
          EPA Genetox Program 1986, Inconclusive: E coli polA without S9
          EPA Genetox Program 1986, Inconclusive: D melanogaster Sex-linked
           lethal
          EPA TSCA Test Submission (TSCATS) Data Base, June 1987
          Meets criteria for proposed OSHA Medical Records Rule
-OTHER DATA (Regulatory)
 ======================
*PROPER SHIPPING NAME (IATA): Not restricted
*UN/ID NUMBER:
*HAZARD CLASS:              SUBSIDIARY RISK:          PACKING GROUP:
*LABELS REQUIRED:
*PACKAGING: PASSENGER: PKG. INSTR.:                 MAXIMUM QUANTITY:
            CARGO    : PKG. INSTR.:                 MAXIMUM QUANTITY:
*SPECIAL PROVISIONS:
*USES:
  Insecticide and military product.
*COMMENTS:
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Metabolite of DDT; pesticide degradation product.

-HANDLING PROCEDURES

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*ACUTE/CHRONIC HAZARDS:

This compound is harmful if ingested, inhaled or absorbed through the skin. It may cause irritation [269]. There is clear evidence that this compound is an animal carcinogen [015]. When heated to decomposition it emits very toxic fumes of CO and CO2 [269]. It may also emit toxic fumes of HCl gas [042,269].

*MINIMUM PROTECTIVE CLOTHING:

If Tyvek-type disposable protective clothing is not worn during handling of this chemical, wear disposable Tyvek-type sleeves taped to your gloves.

*RECOMMENDED GLOVE MATERIALS:

GlovES Expert System Recommended Gloves For Use With Neat (Undiluted) Chemical:

This chemical has not been tested for permeation by Radian Corporation; however, the GlovES expert system was used to extrapolate permeation test information from compounds in the same chemical class and the following recommendation(s) are provided. The GlovES system uses permeation data from literature sources; therefore, extra safety margins should be used with the recommended exposure times. If this chemical comes into contact with your glove, or if a tear, puncture or hole develops, remove them at once.

Suggested Glove Type	Model Number	Thickness	Estimated Breakthrough
Unknown	North Silvershield	0.10 mm	480 min.
Butyl rubber	North B-161	0.61 mm	480 min.
Neoprene	Edmont 29-840	0.38 mm	480 min.
Teflon	Clean Room Products	0.05 mm	480 min.

*RECOMMENDED RESPIRATOR:

Where the neat test chemical is weighed and diluted, wear a NIOSH-approved half face respirator equipped with a combination filter cartridge, i.e. organic vapor/acid gas/HEPA (specific for organic vapors, HCl, acid gas, SO2 and a high efficiency particulate filter).

*OTHER:

Since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

*STORAGE PRECAUTIONS:

You should protect this material from exposure to light. Keep it away from oxidizing materials and store it under refrigerated temperatures.

*SPILLS AND LEAKAGE:

Should a spill occur while you are handling this chemical, FIRST REMOVE ALL SOURCES OF IGNITION, then you should dampen the solid spill material with 60-70% ethanol and transfer the dampened material to a suitable container. Use absorbent paper dampened with 60-70% ethanol to pick up any remaining material. Seal the absorbent paper, and any of your clothes, which may be contaminated, in a vapor-tight plastic bag for eventual disposal. Solvent wash all contaminated surfaces with 60-70% ethanol followed by washing with a soap and water solution. Do not reenter the contaminated area until the Safety Officer (or other responsible person) has verified that the area has been properly cleaned.

*DISPOSAL AND WASTE TREATMENT: Not available

-EMERGENCY PROCEDURES

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*SKIN CONTACT:

IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water.

IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop.

IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.

*INHALATION:

IMMEDIATELY leave the contaminated area; take deep breaths of fresh air.

IMMEDIATELY call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop.

Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Respirator Recommendation.

*EYE CONTACT:

First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center.

Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician.

IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

*INGESTION:

DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician.

If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

*SYMPTOMS:

Symptoms of exposure to this compound may include liver and kidney damage [052]. Based on data for a similar compound, symptoms may also include vomiting, headache, fatigue, malaise, numbness and partial paralysis of the extremities, moderate ataxia, exaggeration of part of the reflexes, mild convulsions, loss of porprioception and vibratory sensation of the extremities, hyperactive knee-jerk reflexes, excitement, confusion and increased respiration [215]. It may also cause nausea and diarrhea [042]. Other symptoms may include tremors of the head and neck muscles, cardiac and respiratory failure and even death [031]. It may also cause paresthesias of the tongue, lips and face, irritability and dizziness [406]. It may cause tonic and clonic convulsions [031,406]. Other symptoms include apprehension and hyperesthesia of the mouth and face [215,406]. It may also cause "yellow vision" [099].

-SOURCES
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*SOURCES:

[015] Lewis, R.J., Sr. and R.L. Tatken, Eds. Registry of Toxic Effects of Chemical Substances. Microfiche Ed. National Institute for Occupational Safety and Health. Cincinnati, OH. Quarterly Updates. KV9450000.

[025] Buckingham, J., Ed. Dictionary of Organic Compounds. 5th Ed. Chapman and Hall. New York. 1982. Vol. 2, p. 1713, #D02450.

[031] Windholz, M., Ed. The Merck Index. 10th Ed. Merck and Co. Rahway, NJ. 1983. pp. 209-210, #2823.

[042] Sax, N.I. Dangerous Properties of Industrial Materials. 6th Ed. Van Nostrand Reinhold. New York. 1984. pp. 465, 854-856.

[052] Midwest Research Institute. MRI Report for DDE. Kansas City, MO. June 2, 1977; October 19, 1977.

[055] Verschueren, K. Handbook of Environmental Data on Organic Chemicals. 2nd Ed. Van Nostrand Reinhold. New York. 1983. pp. 434-436.

[062] Sax, N.I. and R.J. Lewis Sr., Eds. Hawley's Condensed Chemical Dictionary. 11th Ed. Van Nostrand Reinhold. New York. 1987. p. 345.

[082] U.S. Environmental Protection Agency, Office of Toxic Substances. Toxic Substances Control Act Chemical Substance Inventory: 1985 Edition. 5 Vols. U.S. Environmental Protection Agency. Washington, D.C. January 1986. Not listed.

[099] Grant, W. Morton, M.D. Toxicology of the Eye. 3rd Ed. Charles

C. Thomas, Publisher. Springfield, IL. 1986. pp. 305-306.
[110] Oak Ridge National Laboratory. Environmental Mutagen Information Center (EMIC), Bibliographic Data Base. Oak Ridge National Laboratory. Oak Ridge, TN. Listed.
[120] Oak Ridge National Laboratory. Environmental Teratogen Information Center (ETIC), Bibliographic Data Base. Oak Ridge National Laboratory. Oak Ridge, TN. Listed.
[165] Wiswesser, W.J., Ed. Pesticide Index. Entomological Society of America. College Park, MD. 1976. pp. 67-68.
[215] Rom, William N., Ed. Environmental and Occupational Medicine. Little, Brown and Company. Boston. 1983. p. 552.
[240] Grayson, Martin, Ed. Kirk-Othmer Encyclopedia of Chemical Technology. Volumes 1-24 and Supplement. 3rd Ed. John Wiley & Sons. New York. 1978-1984. Vol. 13, p. 429; Vol. 21, pp. 265, 268; Vol. 24, pp. 306, 323.
[269] Lenga, Robert E. The Sigma-Aldrich Library of Chemical Safety Data. Edition 1. Sigma-Aldrich Corporation. Milwaukee, WI. 1985. p. 196, #D.
[275] Aldrich Chemical Company. Aldrich Catalog/Handbook of Fine Chemical. Aldrich Chemical Co., Inc. Milwaukee, WI. 1988. p. 182, #12,389-7.
[295] James E.F. Reynolds Ed. Martindale The Extra Pharmacopoeia. 28th Ed. The Pharmaceutical Press. London. 1982. p. 835.
[395] International Agency for Research on Cancer, World Health Organization. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man. International Agency for Research on Cancer. Geneva. Vol. 5, pp. 83-109.
[406] Goodman, L.S., A. Gilman, F. Murad and T.W. Rall, Eds. The Pharmacological Basis of Therapeutics. 7th Ed. Macmillan Publishing Co. New York. 1985. pp. 1638-1639.
[430] Clayton, G.D. and F.E. Clayton, Eds. Patty's Industrial Hygiene and Toxicology. Vol. 2. Third Revised Edition. John Wiley and Sons. New York. 1981. Vol. IIB, pp. 3641, 3685.
[610] Clansky, Kenneth B., Ed. Suspect Chemicals Sourcebook: A Guide to Industrial Chemicals Covered Under Major Federal Regulatory and Advisory Programs. Roytech Publications, Inc. Burlingame, CA. 1990. Section 3, p. 14.
[620] United States National Toxicology Program. Chemical Status Report. NTP Chemtrack System. Research Triangle Park, NC. November 6, 1990. Listed.

NIOSH Pocket Guide to Chemical Hazards

DDT	**CAS** 50-29-3
$(C_6H_4Cl)_2CHCCl_3$	**RTECS** KJ3325000
Synonyms & Trade Names p,p'-DDT; Dichlorodiphenyltrichloroethane; 1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane	**DOT ID & Guide** 2761 151

Exposure Limits	NIOSH REL: Ca TWA 0.5 mg/m^3 See Appendix A
	OSHA PEL: TWA 1 mg/m^3 [skin]

IDLH Ca [500 mg/m^3] See: 50293	**Conversion**

Physical Description
Colorless crystals or off-white powder with a slight, aromatic odor. [pesticide]

MW: 354.5	BP: 230°F (Decomposes)	MLT: 227°F	Sol: Insoluble
VP: 0.0000002 mmHg	IP: ?		Sp.Gr: 0.99
Fl.P: 162-171°F	UEL: ?	LEL: ?	

Combustible Solid

Incompatibilities & Reactivities
Strong oxidizers, alkalis

Measurement Method
Filter; Isooctane; Gas chromatography/Electrochemical detection; II(3) [#S274] See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin; paresthesia tongue, lips, face; tremor; apprehension, dizziness, confusion, malaise (vague feeling of discomfort), headache, fatigue; convulsions; paresis hands; vomiting; [Potential occupational carcinogen]

Target Organs Eyes, skin, central nervous system, kidneys, liver, peripheral nervous system **Cancer Site** [in animals: liver, lung & lymphatic tumors]	
See also: INTRODUCTION See ICSC CARD: 0034 See MEDICAL TESTS: 0065	

ACROS ORGANICS

MATERIAL SAFETY DATA SHEET

Dibenzofuran, 98%
95339

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Dibenzofuran, 98%

Diphenylene oxide
Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410
For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
132-64-9	Dibenzofuran, 98%	98%	205-071-3

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: white.
Caution! The toxicological properties of this material have not been fully investigated. May cause eye and skin irritation. May cause respiratory and digestive tract irritation.
Target Organs: None.

Potential Health Effects
Eye:
May cause eye irritation.
Skin:
May cause skin irritation.
Ingestion:
The toxicological properties of this substance have not been fully investigated.
Inhalation:
May cause respiratory tract irritation.
Chronic:
Not available.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid.

Skin:
Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.

Ingestion:
Get medical aid. Wash mouth out with water.

Inhalation:
Remove from exposure to fresh air immediately. Get medical aid.

Notes to Physician:
Treat symptomatically and supportively.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.

Extinguishing Media:
In case of fire use water spray, dry chemical, carbon dioxide, or chemical foam.

Autoignition Temperature: Not available.
Flash Point: 130 deg C (266.00 deg F)
NFPA Rating: Not published.
Explosion Limits, Lower: Not available.
Upper: Not available.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:
Vacuum or sweep up material and place into a suitable disposal container.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:
Avoid breathing dust, vapor, mist, or gas. Avoid contact with skin and eyes.

Storage:
Store in a cool, dry place. Store in a tightly closed container.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Dibenzofuran, 98%	none listed	none listed	none listed

OSHA Vacated PELs:
Dibenzofuran, 98%:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear chemical goggles.
Skin:
Wear appropriate protective gloves to prevent skin exposure.
Clothing:
Wear a chemical apron.
Respirators:
A NIOSH/MSHA approved air purifying dust or mist respirator or European Standard EN 149.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Solid
Appearance:	white
Odor:	Not available.
pH:	Not available.
Vapor Pressure:	Not available.
Vapor Density:	Not available.
Evaporation Rate:	Not available.
Viscosity:	Not available.
Boiling Point:	285 deg C @ 760.00mm Hg
Freezing/Melting Point:	81 - 83 deg C
Decomposition Temperature:	Not available.
Solubility:	slightly soluble in alcohol, ether, benz
Specific Gravity/Density:	Not available.
Molecular Formula:	$C_{12}H_8O$
Molecular Weight:	168.19

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Not available.
Conditions to Avoid:
Not available.
Incompatibilities with Other Materials:
Strong oxidizing agents.
Hazardous Decomposition Products:
Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 132-64-9: HP4430000
LD50/LC50:
Not available.
Carcinogenicity:
Dibenzofuran, 98% -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Reproductive Effects:
Embryotoxic at 20¦1 when applied to mallard duck eggs (Hoffman, D.J J.Toxicol. Environ. Health 1979)
Other Studies:
Genotoxicity : salmonella typhimurium TA98, TA100, TA1535, T A1537 with and without metabolic activation negative (Fl orin, I Toxicology 1980; Schaeny, R. Mutat.Res. 1982)

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Fish toxicity : time to produce sickness at 5 ppm : brown trout 4

hr ; bluegill sunfish 6 hr; goldfish 6 hr. All species died within 8 hr. Time to produce sickness at 1 ppm : brown trout 22 hr. Water characteristics for tests were pH7, dissolved oxygen conc. 7.5 ppm, total hardness 300ppm (soap method), methyl orange alkalinity 310ppm, free carbon dioxide 5 ppm, temperature 35_C (USEPA August 1987. Part I : The toxicity of 3400 chemicals to fish EPA 560/6-87-002)

Environmental Fate:
Not available.

Physical/Chemical:
Not available.

Other:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants:
None listed.
RCRA D-Series Chronic Toxicity Reference Levels: None listed.
RCRA F-Series: None listed.
RCRA P-Series: None listed.
RCRA U-Series: None listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
No information available

IMO
Not regulated as a hazardous material.

IATA
Not regulated as a hazardous material.

RID/ADR
Not regulated as a hazardous material.

Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL

TSCA
CAS# 132-64-9 is listed on the TSCA inventory.

Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.

Section 12b
None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.

SARA

Section 302 (RQ)
None of the chemicals in this material have an RQ.

Section 302 (TPQ)
None of the chemicals in this product have a TPQ.

Section 313
This material contains Dibenzofuran, 98% (CAS# 132-64-9, 98%), which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:
CAS# 132-64-9 is listed as a hazardous air pollutant (HAP).

This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

Dibenzofuran, 98% can be found on the following state right to know lists: New Jersey, Pennsylvania, Massachusetts.
California No Significant Risk Level:
None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols: Not available.
Risk Phrases:
Safety Phrases:
S 24/25 Avoid contact with skin and eyes.

WGK (Water Danger/Protection)
CAS# 132-64-9: No information available

Canada
CAS# 132-64-9 is listed on Canada's DSL/NDSL List.
WHMIS: Not available.
CAS# 132-64-9 is not listed on Canada's Ingredient Disclosure List.

Exposure Limits

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 7/17/1995 Revision #4 Date: 9/02/1997

Back to product information.

NIOSH Pocket Guide to Chemical Hazards

Dieldrin			CAS 60-57-1
$C_{12}H_8Cl_6O$			RTECS IO1750000
Synonyms & Trade Names HEOD; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,exo-5,8-dimethanonaphthalene			**DOT ID & Guide** 2761 151
Exposure Limits	NIOSH REL: Ca TWA 0.25 mg/m^3 [skin] See Appendix A		
	OSHA PEL: TWA 0.25 mg/m^3 [skin]		
IDLH Ca [50 mg/m^3] See: 60571		**Conversion**	
Physical Description Colorless to light-tan crystals with a mild, chemical odor. [insecticide]			
MW: 380.9	BP: Decomposes	MLT: 349°F	Sol: 0.02%
VP(77°F): 8 x 10-7 mmHg	IP: ?		Sp.Gr: 1.75
FI.P: NA	UEL: NA	LEL: NA	
Noncombustible Solid			
Incompatibilities & Reactivities Strong oxidizers, active metals such as sodium, strong acids, phenols			
Measurement Method Filter; Isooctane; Gas chromatography/Electrochemical detection; II(3) [#S283] See: NMAM INDEX			
Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench		**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately	
Respirator Recommendations NIOSH At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus			
Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact			
Symptoms headache, dizziness; nausea, vomiting, malaise (vague feeling of discomfort), sweating; myoclonic limb jerks; clonic, tonic convulsions; coma; [Potential occupational carcinogen]; in animals: liver, kidney damage			

Target Organs central nervous system, liver, kidneys, skin	
Cancer Site [in animals: lung, liver, thyroid & adrenal gland tumors]	
See also: INTRODUCTION See ICSC CARD: 0787 See MEDICAL TESTS: 0077	

NIOSH Pocket Guide to Chemical Hazards

2,3,7,8-Tetrachloro-dibenzo-p-dioxin	CAS 1746-01-6
$C_{12}H_4Cl_4O_2$	**RTECS** HP3500000
Synonyms & Trade Names Dioxin; Dioxine; TCDBD; TCDD; 2,3,7,8-TCDD [Note: Formed during past production of 2,4,5-trichlorophenol, 2,4,5-T & 2(2,4,5-trichlorophenoxy)propionic acid.]	**DOT ID & Guide**

Exposure Limits	NIOSH REL: Ca See Appendix A
	OSHA PEL: none

IDLH Ca [N.D.] See: IDLH INDEX	**Conversion**

Physical Description
Colorless to white, crystalline solid. [Note: Exposure may occur through contact at previously contaminated worksites.]

MW: 322.0	BP: Decomposes	MLT: 581°F	Sol: 0.00000002%
VP(77°F): 0.000002 mmHg	IP: ?		Sp Gr: ?
FI.P: ?	UEL: ?	LEL: ?	

Incompatibilities & Reactivities
UV light (decomposes)

Measurement Method
None available See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes; allergic dermatitis, chloracne; porphyria; gastrointestinal disturbance; possible reproductive, teratogenic effects; in animals: liver, kidney damage; hemorrhage; [Potential occupational carcinogen]

Target Organs Eyes, skin, liver, kidneys, reproductive system **Cancer Site** [in animals: tumors at many sites]
See also: INTRODUCTION

NIOSH Pocket Guide to Chemical Hazards

Heptachlor	**CAS** 76-44-8
$C_{10}H_5Cl_7$	**RTECS** PC0700000
Synonyms & Trade Names 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene	**DOT ID & Guide** 2761 151 (organochlorine pesticide, solid)

Exposure Limits	NIOSH REL: Ca TWA 0.5 mg/m^3 [skin] See Appendix A
	OSHA PEL: TWA 0.5 mg/m^3 [skin]

IDLH Ca [35 mg/m^3] See: 76448	**Conversion**

Physical Description
White to light-tan crystals with a camphor-like odor. [insecticide]

MW: 373.4	BP: 293°F (Decomposes)	MLT: 203°F	Sol: 0.0006%
VP(77°F): 0.0003 mmHg	IP: ?		Sp.Gr: 1.66
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid, but may be dissolved in flammable liquids.

Incompatibilities & Reactivities
Iron, rust

Measurement Method
Chromosorb tube-102; Toluene; Gas chromatography/Electrochemical detection; II(5) [#S287]
See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms In animals: tremor, convulsions; liver damage; [Potential occupational carcinogen]

Target Organs central nervous system,liver **Cancer Site** [in animals: liver cancer]
See also: INTRODUCTION See ICSC CARD: 0743

Environmental Health Center

Heptachlor ($C_{10}H_5Cl_7$) / Heptachlor Epoxide ($C_{10}H_5Cl_7O$) Chemical Backgrounder

Description:

Heptachlor (C.A.S. 76-44-8) is a man-made compound that was commonly used by exterminators and home owners to control and kill termites, and by farmers to kill insects in seed grains and on crops. Heptachlor epoxide is an oxidation product of heptachlor formed by many plants and animals, including people, after exposure to heptachlor. Heptachlor is present as an impurity in the pesticide chlordane.

Since late 1978, most uses of heptachlor have been phased out; the chemical is no longer available to the general public. As of April 1988, heptachlor can no longer be used for the underground control of termites.

Chemical properties:

Heptachlor is a crystalline solid when it is pure, and a waxy solid as a technical-grade product. Heptachlor epoxide is a solid. Heptachlor is soluble in water; heptachlor epoxide is insoluble. As a pure compound, heptachlor is a light tan solid that smells some-thing like camphor. Synonyms for heptachlor are: 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene; heptachlorodi-cyclopentadiene.

Synonyms for heptachlor epoxide are 1,4,5,6,7,8,8-heptachloro- 2,3-epoxy-2,3,3a,7,7a-hexahydro-4,7-methanoindene; epoxyheptachlor.

Health effects:

Heptachlor and heptachlor epoxide are clearly toxic to animals and humans. How they affect human health depends on the amount and extent of exposure. Most heptachlor and heptachlor epoxide are absorbed readily through the gastrointestinal tract, but inhalation and skin contact are also potential routes of exposure.

Long-term exposure to heptachlor or heptachlor epoxide may affect the liver. There is evidence that heptachlor and heptachlor epoxide are associated with infertility and improper development of offspring.

There is little information available regarding human health effects from brief exposures to high levels of heptachlor. Although there are reports of acute and chronic toxicity in humans because of exposure to heptachlor, with symptoms including tremors, convulsions, kidney damage, respiratory collapse, and death, details of such episodes are not well documented.

A Federal Drug Administration study of estimated dietary intake of heptachlor epoxide by geographic region indicates that toddlers and infants from the north central region of the United States are at greater risk of heptachlor epoxide exposure than those in other sections of the country.

A possibly significant area of exposure risk involves people, especially military personnel, whose homes have been treated with heptachlor for termite control. People whose homes have been treated may continue to be exposed to this chemical through the air over long periods of time.

Economics:

Only one U.S. company, Velsicol Chemical Company, manufactured heptachlor until August 1987, when it voluntarily stopped selling heptachlor and chlordane. Heptachlor epoxide is not produced commercially in the United States.

No information is available about importation of heptachlor or heptachlor epoxide.

Regulation:

The Occupational Safety and Health Administration (OSHA) has established permissible exposure limits for heptachlor.

Cancellation of most uses of heptachlor was announced in 1978. Uses that were cancelled and their cancellation dates are:

- Field corn treatment - August 1, 1980
- Seed treatment (barley, oats, wheat, and rye corn) - September 1, 1982;
- (sorghum) - July 1, 1983
- Citrus, Florida - December 31, 1979
- Pineapples - December 31, 1982
- Narcissus bulbs - December 31, 1980

Heptachlor and heptachlor epoxide are not regulated by EPA under the Clean Air Act. Heptachlor is regulated as a hazardous substance under Section 311 of the Clean Water Act. Heptachlor and heptachlor epoxide are listed under Section 307 of the Federal Water Pollution Control Act as toxic pollutants.

Heptachlor and heptachlor epoxide are regulated as hazardous substances under Superfund. EPA in 1981 initiated a Label Improvement Program to reduce the potential risk for pesticide application of heptachlor.

Under the Emergency Planning and Community Right-to-Know Act of 1986, releases of more than one pound of heptachlor into the air, water, or land must be reported annually and entered into the National Toxic Release Inventory (TRI) data base. In 1987, 7,286 pounds of heptachlor were released in only two states: Illinois (5,500 pounds), and Tennessee (1,786 pounds).

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Environmental Health Center
A Division of the National Safety Council
1025 Connecticut Avenue, NW, Suite 1200, Washington, DC 20036
(202) 293-2270 (tel); (202) 293-0032 (fax)

National Safety Council

July 1, 1997 | Disclaimer/Policy

ANALYTICAL PRODUCTS GROUP -- HEXAVALENT CHROMIUM LEVEL 1 AND 2
MATERIAL SAFETY DATA SHEET
NSN: 664000N043978
Manufacturer's CAGE: 0HWA6
Part No. Indicator: A
Part Number/Trade Name: HEXAVALENT CHROMIUM LEVEL 1 AND 2

General Information

Company's Name: ANALYTICAL PRODUCTS GROUP INC
Company's Street: 2730 WASHINGTON BLVD
Company's City: BELPRE
Company's State: OH
Company's Country: US
Company's Zip Code: 45714
Company's Emerg Ph #: 800-272-4442
Company's Info Ph #: 614-423-4200
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SMJ
Date MSDS Prepared: 01OCT91
Safety Data Review Date: 27NOV95
MSDS Preparer's Name: R.A.T.
Preparer's Company: SAME
MSDS Serial Number: BTLQP
Hazard Characteristic Code: T6

Ingredients/Identity Information

Proprietary: NO
Ingredient: DICHROMIC ACID, DIPOTASSIUM SALT; (POTASSIUM DICHROMATE) (SARA III)
Ingredient Sequence Number: 01
Percent: <0.02
NIOSH (RTECS) Number: HX7680000
CAS Number: 7778-50-9
OSHA PEL: 0.1 PPM (CRO*3), C
ACGIH TLV: 0.5 MG/M3 (CR)

Proprietary: NO
Ingredient: WATER
Ingredient Sequence Number: 02
Percent: >99
NIOSH (RTECS) Number: ZC0110000
CAS Number: 7732-18-5
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Physical/Chemical Characteristics

Appearance And Odor: COLORLESS TO PALE YELLOW LIQUID W/NO ODOR.
Boiling Point: >212F,>100C
Melting Point: 32.0F,0.0C
Vapor Pressure (MM Hg/70 F): 760 @100C
Vapor Density (Air=1): 47.9
Evaporation Rate And Ref: NOT APPLICABLE
Solubility In Water: NOT APPLICABLE

Fire and Explosion Hazard Data

Flash Point: NOT APPLICABLE
Lower Explosive Limit: N/A
Upper Explosive Limit: N/A

Extinguishing Media: SAMPLE IS NON-FLAMMABLE, USE EXTINGUISHER MEDIA APPROPRIATE FOR SURROUNDING FIRE.
Special Fire Fighting Proc: USE NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire And Expl Hazrds: NONE SPECIFIED BY MANUFACTURER.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NOT APPLICABLE
Materials To Avoid: WATER REACTIVE MATERIALS.
Hazardous Decomp Products: NOT APPLICABLE
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT

Health Hazard Data

LD50-LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: ACUTE:NO. CHRONIC:CHROMIUM IS A HUMAN POISON BY INGESTION. LONG TERM EFFECTS ARE LOCALIZED ITCHING, BURNING & DERMATITIS. INDIVIDUALS W/BRONCHIAL ASTHMA CAN BE AFFECTED. THE METAL IS A SEVERE IRRITANT OF THE MUCOUS MEMBRANES.
Carcinogenicity - NTP: YES
Carcinogenicity - IARC: YES
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: POTASSIUM DICHROMATE:IARC MONOGRAPHS ON (SUPDAT)
Signs/Symptoms Of Overexp: SEE HEALTH HAZARDS.
Med Cond Aggravated By Exp: INDIVIDUALS W/DERMATITIS.
Emergency/First Aid Proc: SEEK MED ASSISTANCE FOR TREATMENT, OBSERVATION & SUPPORT IF NEC. INHAL:REMOVE TO FRESH AIR. SUPPORT BRTHG (GIVE O2/ARTF RESP) (FP N). EYE:WASH IMMED W/LG AMT OF WATER, OCCAS LIFTING UPPER & LOWER LIDS (FOR AT LST 15-20 MINS). SKIN:WASH AFFECTED AREA W/SOAP & LG AMT OF WATER (15-20 MINS). IN CASE OF CHEM BURNS, COVER AREA W/ STERILE, DRY PAD. INGEST:DRINK LG QTYS OF WATER/MILK. IF VOMIT (SUPDAT)

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: ADD NEUTRALIZING AGENT, FLUSH TO SEWER.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Method: OBSERVE ALL FEDERAL, STATE & LOCAL REGULATIONS. SAMPLES SHOULD BE DILUTED FOR DISPOSAL UNLESS LOCAL PRACTICE PROCEDURES SPECIFY OTHERWISE.
Precautions-Handling/Storing: THESE ANALYTICAL STANDARDS MAY BE STORED IN NON-HAZARDOUS CHEMICAL STORAGE.
Other Precautions: NEVER HEAT OR EVAPORATE ANALYTICAL STANDARDS TO DRYNESS.

Control Measures

Respiratory Protection: DEPENDS ON CONTAMINATION LEVELS IN THE WORKPLACE. NIOSH/MSHA APPROVED RESPIRATOR APPROPRIATE FOR EXPOSURE OF CONCERN (FP N).
Ventilation: LOCAL EXHAUST.
Protective Gloves: VINYL OR LATEX GLOVES.
Eye Protection: ANSI APVD CHEMICAL SAFETY GOGGLES (FP N)
Other Protective Equipment: EMPLYER SHLD PROVIDE ANSI APVD EYE-WASH FOUNTAIN & QUICK-DRENCH SHWR W/IN IMMED WORKPLACE. GOOD CHEM HYG PRACTICE(SUPDAT
Work Hygienic Practices: NONE SPECIFIED BY MANUFACTURER.
Suppl. Safety & Health Data: HMIS(LEVIEN) NOTES THAT THE ORAL LD50 (RAT) FOR POTASSIUM DICHROMATE IS 190MG/KG.EXPLAN OF CARCIN:GRP 1. NTP 6TH ANNUAL

RPT ON CARCINS, 1991:KNOWN TO BE CARCINOGENIC. FIRST AID PROC:PERSISTS, ADMIN FLUIDS REPEATEDLY. OTHER PROT EQUIP:REQS LAB COAT/APRON.

Transportation Data

Disposal Data

Label Data

Label Required: YES
Technical Review Date: 07OCT93
Label Date: 28SEP93
Label Status: G
Common Name: HEXAVALENT CHROMIUM LEVEL 1 AND 2
Chronic Hazard: YES
Signal Word: NONE
Acute Health Hazard-None: X
Contact Hazard-None: X
Fire Hazard-None: X
Reactivity Hazard-None: X
CANCER HAZARD. CONTAINS POTASSIUM DICHROMATE, WHICH IS LISTED AS A CARCINOGEN (FP N). CHROMIUM IS A HUMAN POISON BY INGESTION. LONG TERM EFFECTS ARE LOCALIZED ITCHING, BURNING & DERMATITIS. INDIVIDUALS W/ BRONCHIAL ASTHMA CAN BE AFFECTED. THE METAL IS A SEVERE IRRITANT OF THE MUCOUS MEMBRANES.
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: ANALYTICAL PRODUCTS GROUP INC
Label Street: 2730 WASHINGTON BLVD
Label City: BELPRE
Label State: OH
Label Zip Code: 45714
Label Country: US
Label Emergency Number: 800-272-4442

NIOSH Pocket Guide to Chemical Hazards

Lead	**CAS** 7439-92-1
Pb	**RTECS** OF7525000
Synonyms & Trade Names Lead metal, Plumbum	**DOT ID & Guide**

Exposure Limits	NIOSH REL*: TWA 0.100 mg/m^3 See Appendix C [*Note: The REL also applies to other lead compounds (as Pb) -- see Appendix C.]
	OSHA PEL*: [1910.1025] TWA 0.050 mg/m^3 See Appendix C [*Note: The PEL also applies to other lead compounds (as Pb) -- see Appendix C.]

IDLH 100 mg/m^3 (as Pb) See: 7439921	**Conversion**

Physical Description
A heavy, ductile, soft, gray solid.

MW: 207.2	BP: 3164°F	MLT: 621°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 11.34
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid in bulk form.

Incompatibilities & Reactivities
Strong oxidizers, hydrogen peroxide, acids

Measurement Method
Filter; HNO_3/H_2O_2; Flame atomic absorption spectrometry; IV [#7082] [Also #7105, #7300, #7700, #7701, #7702] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: Daily Remove: When wet or contaminated Change: Daily	Eye: Irrigate immediately Skin: Soap flush promptly Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations OSHA

Up to 0.5 mg/m^3: (APF = 10) Any air-purifying respirator with a high-efficiency particulate filter/(APF = 10) Any supplied-air respirator

Up to 1.25 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/(APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter

Up to 2.5 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 50 mg/m^3: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Up to 100 mg/m^3: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms weakness, lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypotension
Target Organs Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue
See also: INTRODUCTION See ICSC CARD: 0052 See MEDICAL TESTS: 0127

NIOSH Pocket Guide to Chemical Hazards

Lindane	**CAS** 58-89-9
$C_6H_6Cl_6$	**RTECS** GV4900000
Synonyms & Trade Names BHC; HCH; gamma-Hexachlorocyclohexane; gamma isomer of 1,2,3,4,5,6-Hexachlorocyclohexane	**DOT ID & Guide** 2761 151

Exposure Limits	NIOSH REL: TWA 0.5 mg/m^3 [skin]
	OSHA PEL: TWA 0.5 mg/m^3 [skin]

IDLH 50 mg/m^3 See: 58899	**Conversion**

Physical Description
White to yellow, crystalline powder with a slight, musty odor. [pesticide]

MW: 290.8	BP: 614°F	MLT: 235°F	Sol: 0.001%
VP: 0.00001 mmHg	IP: ?		Sp.Gr: 1.85
FI.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid, but may be dissolved in flammable liquids.

Incompatibilities & Reactivities
Corrosive to metals

Measurement Method
Filter/Bubbler; Isooctane; Gas chromatography/Electrolytic conductivity detection; IV [#5502]
See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: Prevent skin contact Eyes: N.R. Wash skin: When contaminated Remove: When wet or contaminated Change: Daily Provide: Quick drench	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 5 mg/m^3: (APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter/(APF = 10) Any supplied-air respirator

Up to 12.5 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode*/(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s) in combination with a dust, mist, and fume filter*

Up to 25 mg/m^3: (APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter/(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter*/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 50 mg/m^3: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact
Symptoms irritation eyes, skin, nose, throat; headache; nausea; clonic convulsions; respiratory difficulty; cyanosis; aplastic anemia; muscle spasm; in animals: liver, kidney damage
Target Organs Eyes, skin, respiratory system, central nervous system, blood, liver, kidneys
See also: INTRODUCTION See ICSC CARD: 0053 See MEDICAL TESTS: 0128

NIOSH Pocket Guide to Chemical Hazards

Magnesium oxide fume	CAS 1309-48-4
MgO	**RTECS** OM3850000
Synonyms & Trade Names Magnesia fume	**DOT ID & Guide**

Exposure Limits	NIOSH REL: See Appendix D
	OSHA PEL†: TWA 15 mg/m^3

IDLH 750 mg/m^3 See: 1309484	**Conversion**

Physical Description
Finely divided white particulate dispersed in air. [Note: Exposure may occur when magnesium is burned, thermally cut, or welded upon.]

MW: 40.3	BP: 6512°F	MLT: 5072°F	Sol(86°F): 0.009%
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 3.58
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid

Incompatibilities & Reactivities
Chlorine trifluoride, phosphorus pentachloride

Measurement Method
Filter; Acid; Inductively coupled plasma; IV [#7300, Elements] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: N.R. Eyes: N.R. Wash skin: N.R. Remove: N.R. Change: N.R.	Breathing: Respiratory support

Respirator Recommendations OSHA

Up to 150 mg/m^3: (APF = 10) Any dust, mist, and fume respirator/(APF = 10) Any supplied-air respirator

Up to 375 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/(APF = 25) Any powered, air-purifying respirator with a dust, mist, and fume filter

Up to 750 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin and/or eye contact	
Symptoms irritation eyes, nose; metal fume fever: cough, chest pain, flu-like fever	
Target Organs Eyes, respiratory system	
See also: INTRODUCTION See ICSC CARD: 0504	

NIOSH Pocket Guide to Chemical Hazards

Manganese compounds and fume (as Mn)	CAS 7439-96-5 (metal)
Mn (metal)	**RTECS** OO9275000 (metal)
Synonyms & Trade Names Manganese metal: Colloidal manganese, Manganese-55 Synonyms of other compounds vary depending upon the specific manganese compound.	**DOT ID & Guide**

Exposure Limits	NIOSH REL*: TWA 1 mg/m^3 ST 3 mg/m^3 [*Note: Also see specific listings for Manganese cyclopentadienyl tricarbonyl, Methyl cyclopentadienyl manganese tricarbonyl, and Manganese tetroxide.]
	OSHA PEL*: C 5 mg/m^3 [*Note: Also see specific listings for Manganese cyclopentadienyl tricarbonyl and Methyl cyclopentadienyl manganese tricarbonyl.]

IDLH 500 mg/m^3 (as Mn) See: IDLH INDEX	**Conversion**

Physical Description
A lustrous, brittle, silvery solid

MW: 54.9	BP: 3564°F	MLT: 2271°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 7.20 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Combustible Solid

Incompatibilities & Reactivities
Oxidizers [Note: Will react with water or steam to produce hydrogen.]

Measurement Method
Filter; Acid; Inductively coupled plasma; IV [#7300, Elements] See: NMAM INDEX

Personal Protection & Sanitation Skin: N.R. Eyes: N.R. Wash skin: N.R. Remove: N.R. Change: N.R.	**First Aid** (See procedures) Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH

Up to 10 mg/m^3: (APF = 10) Any dust and mist respirator except single-use and quarter-mask respirators^/(APF = 10) Any supplied-air respirator

Up to 25 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/(APF = 25) Any powered, air-purifying respirator with a dust and mist filter^

Up to 50 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full

facepiece Up to 500 mg/m^3: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion
Symptoms Parkinson's; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); fatigue; kidney damage
Target Organs respiratory system, central nervous system, blood, kidneys
See also: INTRODUCTION

NIOSH Pocket Guide to Chemical Hazards

Mercury compounds [except (organo) alkyls] (as Hg)	CAS 7439-97-6 (metal)
Hg (metal)	**RTECS** OV4550000 (metal)
Synonyms & Trade Names Mercury metal: Colloidal mercury, Metallic mercury, Quicksilver Synonyms of "other" Hg compounds vary depending upon the specific compound.	**DOT ID & Guide** 2809 172 (metal)

Exposure Limits	NIOSH REL: Hg Vapor: TWA 0.05 mg/m^3 [skin] Other: C 0.1 mg/m^3 [skin]
	OSHA PEL†: C 0.1 mg/m^3
IDLH 10 mg/m^3 (as Hg) See: IDLH INDEX	**Conversion**

Physical Description
Metal: Silver-white, heavy, odorless liquid. [Note: "Other" Hg compounds include all inorganic & aryl Hg compounds except (organo) alkyls.]

MW: 200.6	BP: 674°F	FRZ: -38°F	Sol: Insoluble
VP: 0.0012 mmHg	IP: ?		Sp.Gr: 13.6 (metal)
Fl.P: NA	UEL: NA	LEL: NA	
Metal: Noncombustible Liquid			

Incompatibilities & Reactivities
Acetylene, ammonia, chlorine dioxide, azides, calcium (amalgam formation), sodium carbide, lithium, rubidium, copper

Measurement Method
Hopcalite; Acid; AA cold; IV [#6009, Mercury] See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: N.R. Wash skin: When contaminated Remove: When wet or contaminated Change: Daily	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations Mercury vapor:
NIOSH

Up to 0.5 mg/m^3: (APF = 10) Any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern†/(APF = 10) Any supplied-air respirator

Up to 1.25 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/ (APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern†(canister)

Up to 2.5 mg/m^3: (APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge (s) providing protection against the compound of concern†/(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern†/(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/PAPRTS(canister)/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 10 mg/m^3: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus

Other mercury compounds:

NIOSH/OSHA

Up to 1 mg/m^3: (APF = 10) Any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern†/(APF = 10) Any supplied-air respirator

Up to 2.5 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/(APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern†(canister)

Up to 5 mg/m^3: (APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern†/(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern†/(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/PAPRTS(canister)/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 10 mg/m^3: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis pneumonitis; tremor, insomnia, irritability, indecision, headache, fatigue, weakness; stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria

Target Organs Eyes, skin, respiratory system, central nervous system, kidneys

See also: INTRODUCTION

NIOSH Pocket Guide to Chemical Hazards

Molybdenum	CAS 7439-98-7
Mo	RTECS QA4680000
Synonyms & Trade Names Molybdenum metal	**DOT ID & Guide**

Exposure Limits	
	NIOSH REL*: See Appendix D [*Note: The REL also applies to other insoluble molybdenum compounds (as Mo).]
	OSHA PEL*†: TWA 15 mg/m^3 [*Note: The PEL also applies to other insoluble molybdenum compounds (as Mo).]

IDLH 5000 mg/m^3 (as Mo) See: 7439987	**Conversion**

Physical Description
Dark gray or black powder with a metallic luster.

MW: 95.9	BP: 8717°F	MLT: 4752°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 10.28
Fl.P: NA	UEL: NA	LEL: NA	

Combustible Solid in form of dust or powder.

Incompatibilities & Reactivities
Strong oxidizers

Measurement Method
Filter; Acid; Inductively coupled plasma; IV [#7300, Elements] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: N.R. Eyes: N.R. Wash skin: N.R. Remove: N.R. Change: N.R.	Eye: Irrigate immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations OSHA
Up to 75 mg/m^3: (APF = 5) Any dust and mist respirator^
Up to 150 mg/m^3: (APF = 10) Any dust and mist respirator except single-use and quarter-mask respirators^/(APF = 10) Any supplied-air respirator
Up to 375 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode/(APF = 25) Any powered, air-purifying respirator with a dust and mist filter^
Up to 750 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece
Up to 5000 mg/m^3: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode
Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000)

Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms In animals: irritation eyes, nose, throat; anorexia, diarrhea, weight loss; listlessness; liver, kidney damage
Target Organs Eyes, respiratory system, liver, kidneys
See also: INTRODUCTION See MEDICAL TESTS: 0150

NIOSH Pocket Guide to Chemical Hazards

Nickel metal and other compounds (as Ni)	CAS 7440-02-0 (Metal)
Ni (Metal)	RTECS QR5950000 (Metal)
Synonyms & Trade Names Nickel metal: Elemental nickel, Nickel catalyst Synonyms of other nickel compounds vary depending upon the specific compound.	**DOT ID & Guide**

Exposure Limits	NIOSH REL*: Ca TWA 0.015 mg/m^3 See Appendix A [*Note: The REL does not apply to Nickel carbonyl.]
	OSHA PEL*†: TWA 1 mg/m^3 [*Note: The PEL does not apply to Nickel carbonyl.]

IDLH Ca [10 mg/m^3 (as Ni)] See: IDLH INDEX	**Conversion**

Physical Description
Metal: Lustrous, silvery, odorless solid.

MW: 58.7	BP: 5139°F	MLT: 2831°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 8.90 (Metal)
FI.P: NA	UEL: NA	LEL: NA	

Metal: Combustible Solid; nickel sponge catalyst may ignite SPONTANEOUSLY in air.

Incompatibilities & Reactivities
Strong acids, sulfur, selenium, wood & other combustibles, nickel nitrate

Measurement Method
Filter; Acid; Inductively coupled plasma; IV [#7300, Elements] See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: N.R. Wash skin: When contaminated/Daily Remove: When wet or contaminated Change: Daily	**First Aid** (See procedures) Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms sensitization dermatitis, allergic asthma, pneumonitis; [Potential occupational

carcinogen]
Target Organs Nasal cavities, lungs, skin **Cancer Site** [lung and nasal cancer]
See also: INTRODUCTION

NIOSH Pocket Guide to Chemical Hazards

Chlorodiphenyl (54% chlorine)	CAS 11097-69-1
$C_6H_3Cl_2C_6H_2Cl_3$ (approx)	**RTECS** TQ1360000
Synonyms & Trade Names Aroclor® 1254, PCB, Polychlorinated biphenyl	**DOT ID & Guide** 2315 171

Exposure Limits	NIOSH REL*: Ca TWA 0.001 mg/m^3 See Appendix A [*Note: The REL also applies to other PCBs.]
	OSHA PEL: TWA 0.5 mg/m^3 [skin]

IDLH Ca [5 mg/m^3] See: IDLH INDEX	**Conversion**

Physical Description
Colorless to pale-yellow, viscous liquid or solid (below 50°F) with a mild, hydrocarbon odor.

MW: 326 (approx)	BP: 689-734°F	FRZ: 50°F	Sol: Insoluble
VP: 0.00006 mmHg	IP: ?		Sp.Gr(77°F): 1.38
FI.P: NA	UEL: NA	LEL: NA	

Nonflammable Liquid, but exposure in a fire results in the formation of a black soot containing PCBs, polychlorinated dibenzofurans, and chlorinated dibenzo-p-dioxins.

Incompatibilities & Reactivities
Strong oxidizers

Measurement Method
Filter/Florisil tube; Hexane; Gas chromatography/Electrochemical detection; IV [#5503, PCBs]
See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: Daily Provide: Eyewash, Quick drench	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister having a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, chloracne; liver damage; reproductive effects; [Potential occupational carcinogen]

Target Organs Skin, eyes, liver, reproductive system

Cancer Site [in animals: tumors of the pituitary gland & liver, leukemia]

See also: INTRODUCTION See ICSC CARD: 0939 See MEDICAL TESTS: 0176

NIOSH Pocket Guide to Chemical Hazards

Selenium	**CAS** 7782-49-2
Se	**RTECS** VS7700000
Synonyms & Trade Names Elemental selenium, Selenium alloy	**DOT ID & Guide** 2658 152 (powder)

Exposure Limits	NIOSH REL*: TWA 0.2 mg/m^3 [*Note: The REL also applies to other selenium compounds (as Se) except Selenium hexafluoride.]
	OSHA PEL*: TWA 0.2 mg/m^3 [*Note: The PEL also applies to other selenium compounds (as Se) except Selenium hexafluoride.]

IDLH 1 mg/m^3 (as Se) See: 7782492	**Conversion**

Physical Description
Amorphous or crystalline, red to gray solid. [Note: Occurs as an impurity in most sulfide ores.]

MW: 79.0	BP: 1265°F	MLT: 392°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 4.28
Fl.P: NA	UEL: NA	LEL: NA	

Combustible Solid

Incompatibilities & Reactivities
Acids, strong oxidizers, chromium trioxide, potassium bromate, cadmium

Measurement Method
Filter; Acid; Inductively coupled plasma; IV [#7300, Elements] [Also II(7) #S190] See: NMAM INDEX

Personal Protection & Sanitation Skin: Prevent skin contact Eyes: N.R. Wash skin: When contaminated Remove: When wet or contaminated Change: N.R. Provide: Quick drench	**First Aid** (See procedures) Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA
Up to 1 mg/m^3: (APF = 5) Any dust and mist respirator^*/(APF = 10) Any dust, mist, and fume respirator*/(APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 25) Any powered, air-purifying respirator with a dust and mist filter^*/(APF = 25) Any powered, air-purifying respirator with a dust, mist, and fume filter*/(APF = 10) Any supplied-air respirator*/(APF = 50) Any self-contained breathing apparatus with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms irritation eyes, skin, nose, throat; visualdisturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breathing, gastrointestinal disturbance; dermatitis; eye, skin burns; in animals: anemia; liver necrosis, cirrhosis; kidney, spleen damage
Target Organs Eyes, skin, respiratory system, liver, kidneys, blood, spleen
See also: INTRODUCTION See ICSC CARD: 0072 See MEDICAL TESTS: 0202

NIOSH Pocket Guide to Chemical Hazards

Silver (metal dust and soluble compounds, as Ag)	CAS 7440-22-4 (metal)
Ag (metal)	RTECS VW3500000 (metal)
Synonyms & Trade Names Silver metal: Argentum Synonyms of soluble silver compounds such as Silver nitrate ($AgNO_3$) vary depending upon the specific compound.	**DOT ID & Guide**

Exposure Limits	NIOSH REL: TWA 0.01 mg/m^3
	OSHA PEL: TWA 0.01 mg/m^3
IDLH 10 mg/m^3 (as Ag) See: IDLH INDEX	**Conversion**

Physical Description
Metal: White, lustrous solid.

MW: 107.9	BP: 3632°F	MLT: 1761°F	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 10.49 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid, but flammable in form of dust or powder.

Incompatibilities & Reactivities
Acetylene, ammonia, hydrogen peroxide, bromoazide, chlorine trifluoride, ethyleneimine, oxalic acid, tartaric acid

Measurement Method
Filter; Acid; Inductively coupled plasma; IV [#7300, Elements] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated ($AgNO_3$) Change: Daily Provide: Eyewash	Eye: Irrigate immediately Skin: Water flush Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH/OSHA

Up to 0.25 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode£/(APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter£

Up to 0.5 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 10 mg/m^3: (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full

facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms Blue-gray eyes, nasal septum, throat, skin; irritation, ulceration skin; gastrointestinal disturbance
Target Organs Nasal septum, skin, eyes
See also: INTRODUCTION

NIOSH Pocket Guide to Chemical Hazards

Toluene	**CAS** 108-88-3
$C_6H_5CH_3$	**RTECS** XS5250000
Synonyms & Trade Names Methyl benzene, Methyl benzol, Phenyl methane, Toluol	**DOT ID & Guide** 1294 130

Exposure Limits	NIOSH REL: TWA 100 ppm (375 mg/m^3) ST 150 ppm (560 mg/m^3)
	OSHA PEL†: TWA 200 ppm C 300 ppm 500 ppm (10-minute maximum peak)

IDLH 500 ppm See: 108883	**Conversion** 1 ppm = 3.77 mg/m^3

Physical Description
Colorless liquid with a sweet, pungent, benzene-like odor.

MW: 92.1	BP: 232°F	FRZ: -139°F	Sol(74°F): 0.07%
VP: 21 mmHg	IP: 8.82 eV		Sp.Gr: 0.87
Fl.P: 40°F	UEL: 7.1%	LEL: 1.1%	

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities
Strong oxidizers

Measurement Method
Charcoal tube; CS_2; Gas chromatography/Flame ionization detection; IV [#1500, Hydrocarbons] [Also #4000, #1501] See: NMAM INDEX

Personal Protection & Sanitation
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: N.R.

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash promptly
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
Up to 500 ppm: (APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*/(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*/(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/(APF = 10) Any supplied-air respirator*/(APF = 50) Any self-contained breathing apparatus with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms irritation eyes, nose; fatigue, weakness, confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); nervousness, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage	
Target Organs Eyes, skin, respiratory system, central nervous system, liver, kidneys	
See also: INTRODUCTION See ICSC CARD: 0078 See MEDICAL TESTS: 0232	

NIOSH Pocket Guide to Chemical Hazards

Vanadium dust	**CAS** 1314-62-1
V_2O_5	**RTECS** YW2450000
Synonyms & Trade Names Divanadium pentoxide dust, Vanadic anhydride dust, Vanadium oxide dust, Vanadium pentaoxide dust Other synonyms vary depending upon the specific vanadium compound.	**DOT ID & Guide** 2862 151

Exposure Limits	NIOSH REL*: C 0.05 mg V/m^3 [15-minute] [*Note: The REL applies to all vanadium compounds except Vanadium metal and Vanadium carbide (see Ferrovanadium dust).]
	OSHA PEL†: C 0.5 mg V_2O_5/m^3 (resp)

IDLH 35 mg/m^3 (as V) See: vandust	**Conversion**

Physical Description
Yellow-orange powder or dark-gray, odorless flakes dispersed in air.

MW: 181.9	BP: 3182°F (Decomposes)	MLT: 1274°F	Sol: 0.8%
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 3.36
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Solid, but may increase intensity of fire when in contact with combustible materials.

Incompatibilities & Reactivities
Lithium, chlorine trifluoride

Measurement Method
Filter; Tetrahydrofuran; X-ray diffraction spectrometry; IV [#7504] [Also #7300, Elements] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: N.R.	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH (as V)

Up to 0.5 mg/m^3: (APF = 10) Any air-purifying respirator with a high efficiency particulate filter*/(APF = 10) Any supplied-air respirator*

Up to 1.25 mg/m^3: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode*/ (APF = 25) Any powered, air-purifying respirator with a high-efficiency particulate filter*

Up to 2.5 mg/m^3: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter*/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece

Up to 35 mg/m : (APF = 2000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms irritation eyes, skin, throat; green tongue, metallic taste, eczema; cough; fine rales, wheezing, bronchitis, dyspnea (breathing difficulty)
Target Organs Eyes, skin, respiratory system
See also: INTRODUCTION See ICSC CARD: 0596 See MEDICAL TESTS: 0240

NIOSH Pocket Guide to Chemical Hazards

Vinyl acetate	CAS 108-05-4
CH_2=$CHOOCCH_3$	RTECS AK0875000
Synonyms & Trade Names 1-Acetoxyethylene, Ethenyl acetate, Ethenyl ethanoate, VAC, Vinyl acetate monomer, Vinyl ethanoate	**DOT ID & Guide** 1301 129P

Exposure Limits	NIOSH REL: C 4 ppm (15 mg/m^3) [15-minute]
	OSHA PEL†: none

IDLH N.D. See: IDLH INDEX	**Conversion** 1 ppm = 3.52 mg/m^3

Physical Description
Colorless liquid with a pleasant, fruity odor. [Note: Raw material for many polyvinyl resins.]

MW: 86.1	BP: 162°F	FRZ: -136°F	Sol: 2%
VP: 83 mmHg	IP: 9.19 eV		Sp.Gr: 0.93
Fl.P: 18°F	UEL: 13.4%	LEL: 2.6%	

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities
Acids, bases, silica gel, alumina, oxidizers, azo compounds, ozone [Note: Usually contains a stabilizer (e.g., hydroquinone or diphenylamine) to prevent polymerization.]

Measurement Method
Carbon mol sieve; CH_2Cl_2/Methanol; Gas chromatography/Flame ionization detection; IV [#1453] See: NMAM INDEX

Personal Protection & Sanitation	**First Aid** (See procedures)
Skin: Prevent skin contact Eyes: Prevent eye contact Wash skin: When contaminated Remove: When wet or contaminated Change: N.R. Provide: Eyewash, Quick drench	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately

Respirator Recommendations NIOSH
Up to 40 ppm: (APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)*/(APF = 10) Any supplied-air respirator*
Up to 100 ppm: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode*/(APF = 25) Any powered, air-purifying respirator with organic vapor cartridge(s)*
Up to 200 ppm: (APF = 50) Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)/(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/(APF = 50) Any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s)*/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece
Up to 4000 ppm: (APF = 1000) Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode*
Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-

demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Exposure Routes inhalation, ingestion, skin and/or eye contact
Symptoms irritation eyes, skin, nose, throat; hoarseness, cough; loss of smell; eye burns, skin blisters
Target Organs Eyes, skin, respiratory system
See also: INTRODUCTION See ICSC CARD: 0347

Please reduce your browser font size for better viewing and printing.

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

MSDS *Material Safety Data Sheet*

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 202-483-7616

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

MALLINCKRODT J.T.Baker

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

ZINC METAL POWDER

MSDS Number: Z0858 — *Effective Date: 11/17/99*

1. Product Identification

Synonyms: Powdered zinc; blue powder; CI77945; CI Pigment Black 16
CAS No.: 7440-66-6
Molecular Weight: 65.37
Chemical Formula: Zn
Product Codes:
J.T. Baker: 4282
Mallinckrodt: 8681

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Zinc	7440-66-6	96 - 97%	Yes
Zinc Oxide	1314-13-2	0 - 3%	Yes
Lead	7439-92-1	0 - 0.3%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT. MAY FORM COMBUSTIBLE DUST CONCENTRATIONS IN AIR. WATER REACTIVE. MAY AFFECT THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM (lead component).

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 2 - Moderate
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; CLASS D EXTINGUISHER
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
No adverse effects expected but dust may cause mechanical irritation. The effects may be expected to resemble those of inhaling an inert dust; possible difficulty in breathing, sneezing, coughing. When heated, the fumes are highly toxic and may cause fume fever.
Ingestion:
Extremely large oral dosages may produce gastrointestinal disturbances, due both to mechanical effects and the possibility of reaction with gastric juice to produce zinc chloride. Pain, stomach cramps and nausea could occur in aggravated cases.
Skin Contact:
May cause irritation.
Eye Contact:
May cause irritation.
Chronic Exposure:
No adverse health effects expected.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or impaired respiratory function may be more susceptible to the effects of the substance.

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4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.
Skin Contact:
Wipe off excess material from skin then immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelids occasionally. Get medical attention if irritation persists.

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5. Fire Fighting Measures

Fire:
Autoignition temperature: ca. 460C (ca. 860F)
The listed autoignition temperature is for Zinc powder (layer); dust cloud is ca. 680C (1255F). Zinc powder is not pyrophoric but will burn in air at elevated temperatures.

Bulk dust in damp state may heat spontaneously and ignite on exposure to air. Releases flammable hydrogen gas upon contact with acids or alkali hydroxides. Contact with strong oxidizers may cause fire.

Explosion:

Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

Fire Extinguishing Media:

Smother with a suitable dry powder (sodium chloride, magnesium oxide, Met-L-X).

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Remove all sources of ignition and provide mild ventilation in area of spill. Substance may be pyrophoric and self-ignite. Clean-up personnel require protective clothing, goggles and dust/mist respirators. Sweep or vacuum up the spill in a manner that does not disperse zinc powder in the air and place the zinc in a closed container for recovery or disposal. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

None for Zinc metal.
-OSHA Permissible Exposure Limit (PEL):
10 mg/m3 (TWA), for zinc oxide fume
-ACGIH Threshold Limit Value (TLV):
5 mg/m3 (TWA), 10 mg/m3 (STEL) for zinc oxide fume.

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a full facepiece respirator with dust/mist filter may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Gray or bluish-gray powder.

Odor:
Odorless.

Solubility:
Insoluble in water.

Density:
7.14

pH:
No information found.

% Volatiles by volume @ 21C (70F):
0

Boiling Point:
907C (1665F)

Melting Point:
419C (786F)

Vapor Density (Air=1):
No information found.

Vapor Pressure (mm Hg):
1 @ 487C (909F)

Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Moist zinc dust can react exothermically and ignite spontaneously in air.

Hazardous Decomposition Products:
Hydrogen in moist air, zinc oxide with oxygen at high temperature. Zinc metal, when melted, produces zinc vapor which oxidizes and condenses in air to form zinc fume.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
Zinc powder can react violently with water, sulfur and halogens. Dangerous or potentially dangerous with strong oxidizing agents, lower molecular weight chlorinated hydrocarbons, strong acids and alkalis.

Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Zinc: Irritation skin, human: 300 ug/3D-I mild; investigated as a mutagen.

\Cancer Lists\

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Zinc (7440-66-6)	No	No	None
Zinc Oxide (1314-13-2)	No	No	None
Lead (7439-92-1)	No	No	2B

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

\Chemical Inventory Status - Part 1\

Ingredient	TSCA	EC	Japan	Australia
Zinc (7440-66-6)	Yes	Yes	No	Yes
Zinc Oxide (1314-13-2)	Yes	Yes	Yes	Yes
Lead (7439-92-1)	Yes	Yes	Yes	Yes

\Chemical Inventory Status - Part 2\

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Zinc (7440-66-6)	Yes	Yes	No	Yes

Zinc Oxide (1314-13-2)	Yes	Yes	No	Yes
Lead (7439-92-1)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Zinc (7440-66-6)	No	No	Yes	No
Zinc Oxide (1314-13-2)	No	No	No	Zinc compoun
Lead (7439-92-1)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Zinc (7440-66-6)	1000	No	No
Zinc Oxide (1314-13-2)	No	No	No
Lead (7439-92-1)	10	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: Yes Pressure: No
Reactivity: Yes (Mixture / Solid)

WARNING:
THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: 4Y
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **1** Reactivity: **1** Other: **Water reactive**
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT. MAY FORM COMBUSTIBLE DUST CONCENTRATIONS IN AIR. WATER REACTIVE. MAY AFFECT THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM (lead component).
Label Precautions:
Avoid breathing dust.
Avoid contact with eyes, skin and clothing.
Keep away from heat and flame.
Keep container closed.
Use with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. Get medical attention for any breathing difficulty. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.

Product Use:
Laboratory Reagent
Revision Information:
No changes.
Disclaimer:
****

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****

Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

!! This is an ARCHIVE Record !!

SHML Data

This NIIN is not currently found on the SHML; it requires CO's approval prior to procurement. If procured, submit SHML feedback form to Type Commander for endorsement prior to NAVICP approval.

Nuclear Water Data

This is not a Nuclear Water Chemical NIIN.

Standard PMS Identification Number Data

This is not a Standard PMS Identification Number NIIN.

MSDS Safety Information

FSC: 6810 **NIIN:** 00-063-6101 **MSDS Date:** 01/01/1985 **MSDS Num:** BCWXG

Submitter: N EN **Tech Review:** 04/09/1984 **Status CD:** C

Product ID: ZINC **MFN:** 01

Article: N **Kit Part:** N

Responsible Party **Cage:** 94480

Name: FISHER SCIENTIFIC CO

City: N/P **State:** NK **Zip:** 00000

Country: NK

Emergency Phone Number: 201-796-7100

Preparer's Name: N/P

Proprietary Ind: N **Review Ind:** Y

Published: Y **Special Project CD:** N

Contractor Summary

Cage: 94480 **Name:** FISHER SCIENTIFIC COMPANY

Address: 52 FADEM ROAD,DOMESTIC DIVISION **Box:** N/K

City: SPRINGFIELD **State:** NJ **Zip:** 07081

Country: US **Phone:** 201-796-7100

Item Description Information

Item Manager: NK

Item Name: ZINC,ACS

Specification Number: NK **Type/Grade/Class:** NK

Unit of Issue: NK **Quantitative Expression:** NK
UI Container Qty: NK **Type of Container:**

Ingredients

Cas: 7440-66-6 **Code:** M **RTECS #:** ZG8600000 **Code:** M
Name: ZINC (SARA III)
% Text: N/P **Environmental Wt:**
Other REC Limits: N/P

OSHA PEL: 10 MG ZNO/M3 **Code:** M **OSHA STEL:** **Code:**
ACGIH TLV: 10 MG ZNO/M3; 9192 **Code:** M **ACGIH STEL:** N/P **Code:**
EPA Rpt Qty: 1000 LBS **DOT Rpt Qty:** 1000 LBS

Ozone Depleting Chemical: N

Health Hazards Data

LD50 LC50 Mixture N/P
Route Of Entry Inds - Inhalation: N/P **Skin:** N/P **Ingestion:** N/P
Carcinogenicity Inds - NTP: N/P **IARC:** N/P **OSHA:** N/P

Health Hazards Acute And Chronic

N/P

Explanation Of Carcinogenicity

N/P

Signs And Symptions Of Overexposure

AVOID BREATHING DUST

Medical Cond Aggravated By Exposure

N/P

First Aid

IF INHALED,REMOVE TO FRESH AIR.

Spill Release Procedures

SCOOP UP AND PLACE IN A SUITABLE CONTAINER

Neutralizing Agent

N/P

Waste Disposal Methods

DISPOSE OF BY MEANS AS TO COMPLY WITH ALL LOCAL,STATE AND FEDERAL REGULATIONS.

Handling And Storage Precautions

N/P

Other Precautions

N/P

Fire and Explosion Hazard Information

Flash Point Method: N/P
Flash Point: **Flash Point Text:** N/A
Autoignition Temp: **Autoignition Temp Text:** N/A

Lower Limits: **Upper Limits:**

Extinguishing Media

SPECIAL MIXTURES OF DRY CHEMICALS

Fire Fighting Procedures

N/P

Unusual Fire/Explosion Hazard

FIRE & EXPLOSION HAZARD IN THE FORM OF DUST

Control Measures

Respiratory Protection

NIOSH/MSHA APPROVED RESP DEVICE IN ACCORD WITH EXPOSURE OF CONCERN

Ventilation

LOCAL/MECHANICAL

Protective Gloves

N/P

Eye Protection

SAFETY GLASSES

Other Protective Equipment

N/P

Work Hygienic Practices

N/P

Supplemental Safety and Health

BASE FOR ATOMIC ABSORPTION REFERENCE STANDARD

Physical/Chemical Properties

HCC: N1 **NRC/State LIC No:** N/A

Net Prop WT For Ammo: N/A

Boiling Point: **B.P. Text:** 907C

Melt/Freeze Pt: **M.P/F.P Text:** N/A

Decomp Temp: **Decomp Text:** N/A

Vapor Pres: 1 **Vapor Density:** N/P

Volatile Org Content %: **Spec Gravity:** 7.13

VOC Pounds/Gallon: **PH:** N/P

VOC Grams/Liter: **Viscosity:** N/P

Evaporation Rate & Reference: N/P

Solubility in Water: NEGLIGIBLE

Appearance and Odor: SILVERY METAL (DUST,GRANULES,MOSSY)

Percent Volatiles by Volume: N/P **Corrosion Rate:** N/P

Reactivity Data

Stability Indicator: YES

Stability Condition To Avoid: N/P

Materials To Avoid: N/P

Hazardous Decomposition Products: N/P

Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: N/P

Toxicological Information

Toxicological Information: N/P

Ecological Information

Ecological: N/P

MSDS Transport Information

Transport Information: N/P

Regulatory Information

Sara Title III Information: N/P
Federal Regulatory Information: N/P
State Regulatory Information: N/P

Other Information

Other Information: N/P

HMIS Transportation Information

Responsible Party Cage: 94480
Trans ID NO: 45499
Product ID: ZINC
MSDS Prepared Date: 01/01/1985
Review Date: 05/03/1984
MFN: 1
Submitter: N TN
Status CD: C
Article W/O MSDS: N
Tech Entry NOS Shipping Nm:
Radioactivity:
Form:
Net Explosive Weight:
Coast Guard AMMO Code:
Magnetism: N/P
Net Unit Weight:
AF MMAC Code:
DOD Exemption NUM:
Limited Quantity IND:
Multiple KIT Number: 0
Kit IND: N
Kit Part IND: N
Review IND: Y
Unit Of Issue: NK
Container QTY: NK
Type Of Container:
Additional Data: NOT REGULATED FOR SHIPPING

Detail DOT Information

DOT PSN Code: ZZZ **Symbols:** N/R
DOT Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
DOT PSN Modifier:
Hazard Class: N/R **UN ID Num:** N/R
DOT Packaging Group: N/R
Label: N/R
Special Provision: N/R
Packaging Exception: N/R
Non Bulk Pack: N/R **Bulk Pack:** N/R
Max Qty Pass: N/R **Max Qty Cargo:** N/R
Vessel Stow Req: N/R
Water/Ship/Other Req: N/R

Detail IMO Information

IMO PSN Code: ZZZ
IMO Proper Shipping Name: NOT REGULATED FOR THIS MODE OF TRANSPORTATION
IMO PSN Modifier:
IMDG Page Number: N/R **UN Number:** N/R
UN Hazard Class: N/R **IMO Packaging Group:** N/R
Subsidiary Risk Label: N/R
EMS Number: N/R **MED First Aid Guide NUM:** N/R

Detail IATA Information

IATA PSN Code: ZZZ **IATA UN ID NUM:** N/R
IATA Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
IATA PSN Modifier:
IATA UN Class: N/R **Subsidiary Risk Class:** N/R
IATA Label: N/R
UN Packing Group: N/R **Packing Note Passenger:** N/R
Max Quant Pass: N/R **Max Quant Cargo:** N/R
Packaging Note Cargo: N/R **Exceptions:** N/R

Detail AFI Information

AFI PSN Code: ZZZ **AFI Symbols:**
AFI Proper Shipping Name: NOT REGULATED BY THIS MODE OF TRANSPORTATION
AFI PSN Modifier:
AFI Hazard Class: N/R **AFI UN ID NUM:** N/R
AFI Packing Group: N/R

AFI Label: N/R
Special Provisions: N/A **Back Pack Reference:** N/A

HMIS HAZCOM Label

Print Labels

Product ID: ZINC
Cage: 94480 **Assigned IND:** N
Company Name: FISHER SCIENTIFIC COMPANY
Street: 52 FADEM ROAD DOMESTIC DIVISION **PO Box:** N/K
City: SPRINGFIELD **State:** NJ **Zipcode:** 07081
Country: US
Health Emergency Phone: 201-796-7100
Label Required IND: Y **Date Of Label Review:** 12/16/1998
Status Code: C **MFG Label NO:**
Label Date: 12/16/1998 **Year Procured:** N/K
Origination Code: G **Chronic Hazard IND:** N/P
Eye Protection IND: N/P **Skin Protection IND:** N/P
Signal Word: N/P **Respiratory Protection IND:** N/P
Health Hazard:
Contact Hazard:
Fire Hazard:
Reactivity Hazard:

Hazard And Precautions

AVOID BREATHING DUST

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D REMOVAL ACTION ALTERNATIVE COSTING SUPPORT

Table D-1

Site 32 Alternative 2a: Permeable Reactive Barrier - Iron Wall

POP assumed 30 months

	Unit Price	Unit	Units	Extended Cost	Source
Project Management/Monthly Reporting	$2,200.00	mo	30	$66,000.00	Engineering Estimate
Meetings	$2,000.00	ea	10	$20,000.00	Engineering Estimate
Data Management	$30,000.00	LS	1	$30,000.00	Engineering Estimate
SUBTOTAL				$116,000.00	
Field Task 1 Fe-PRB Design/Construction	Unit Price	Unit	Units	Extended Cost	Source
Data analysis/modeling	$25,000.00	LS	1	$25,000.00	Engineering Estimate
Site Preparation/grading	$8,000.00	LS	1	$8,000.00	Engineering Estimate
Sand [1]	$20.00	ton	2880	$57,600.00	Engineering Estimate
Zero Valent Iron [2]	$550.00	ton	2400	$1,320,000.00	Engineering Estimate
Alta Mats (4 ft by 8 ft)	$220.00	ea	20	$4,400.00	Engineering Estimate
Continuous Trencher	$80,000.00	day	3	$240,000.00	Engineering Estimate
Licensing fee	12% of install fee		1	$194,112.00	Engineering Estimate
Labor and oversight	$1,800.00	day	20	$36,000.00	Engineering Estimate
SUBTOTAL				$1,885,112.00	
Field Task 2 Well Installations	Unit Price	Unit	Units	Extended Cost	Source
Permitting	$2,500.00	LS	1	$2,500.00	Engineering Estimate
Monitoring Well Installation/Develop	$4,500.00	ea	7	$31,500.00	Vendor Quote + Engineering Estimate
IDW Removal (per well)	$540.00	ea	7	$3,780.00	Vendor Quote + Engineering Estimate
IDW Analytical (per well)	$300.00	ea	7	$2,100.00	Vendor Quote + Engineering Estimate
Micropurge Pump + Install	$2,650.00	ea	7	$18,550.00	Vendor Quote
Surveying	$200.00	ea	7	$1,400.00	Vendor Quote
Labor and Oversight	$1,500.00	day	15	$22,500.00	Engineering Estimate
SUBTOTAL				$82,330.00	
Field Task 3 GW Monitoring and Reporting	Unit Price	Unit	Units	Extended Cost	Source
Monitoring	$8,085.00	LS	5	$40,425.00	Table D-4
Reporting	$13,030.00	LS	3	$39,090.00	Table D-5
SUBTOTAL				$79,515.00	
Closeout Report	$35,000.00	LS	1	$35,000.00	
SUBTOTALS				$2,197,957.00	
20% contingency				$439,591.40	
TOTAL PROGRAM				**$2,637,548.40**	
1 - Assume 1.6 tons sand per yd^3					
2 - Assume 2 tons granular iron per yd^3					

Table D-2

Site 32 Alternative 2b: Permeable Reactive Barrier - Bark Mulch Wall

POP assumed 30 months

	Unit Price	Unit	Units	Extended Cost	Source
Project Management/Monthly Reporting	$2,200.00	mo	30	$61,600.00	Engineering Estimate
Meetings	$2,000.00	ea	10	$20,000.00	Engineering Estimate
Data Management	$30,000.00	LS	1	$30,000.00	Engineering Estimate
SUBTOTAL				$111,600.00	
Field Task 1 Bark Wall Design/Construction	Unit Price	Unit	Units	Extended Cost	Source
Data analysis/modeling	$25,000.00	LS	1	$25,000.00	Engineering Estimate
Site Preparation/grading	$15,000.00	LS	1	$15,000.00	Engineering Estimate
Sand [1]	$20.00	ton	3,150	$63,000.00	Engineering Estimate
Black bark mulch [2]	$23.00	yd^3	1,237	$28,451.00	Engineering Estimate
Cement Truck on-site mixing	$2,000.00	day	4	$8,000.00	Engineering Estimate
Alta Mats (4 ft by 8 ft)	$220.00	ea	20	$4,400.00	Engineering Estimate
Continuous Trencher	$80,000.00	day	3	$240,000.00	Engineering Estimate
Labor and oversight	$1,800.00	day	20	$36,000.00	Engineering Estimate
SUBTOTAL				$419,851.00	
Field Task 2 Well Installations	Unit Price	Unit	Units	Extended Cost	Source
Permitting	$2,500.00	LS	1	$2,500.00	Engineering Estimate
Monitoring Well Installation/Develop	$4,500.00	ea	7	$31,500.00	Vendor Quote + Engineering Estimate
IDW Removal (per well)	$540.00	ea	7	$3,780.00	Vendor Quote + Engineering Estimate
IDW Analytical (per well)	$300.00	ea	7	$2,100.00	Vendor Quote + Engineering Estimate
Micropurge Pump + Install	$2,650.00	ea	7	$18,550.00	Vendor Quote
Surveying	$200.00	ea	7	$1,400.00	Vendor Quote
Labor and Oversight	$1,500.00	day	15	$22,500.00	Engineering Estimate
SUBTOTAL				$82,330.00	
Field Task 3 GW Monitoring and Reporting	Unit Price	Unit	Units	Extended Cost	Source
Monitoring	$8,085.00	LS	5	$40,425.00	Table D-4
Reporting	$13,030.00	LS	3	$39,090.00	Table D-5
SUBTOTAL				$79,515.00	
Closeout Report	$35,000.00	LS	1	$35,000.00	
SUBTOTALS				$728,296.00	
20% contingency				$145,659.20	
TOTAL PROGRAM				**$873,955.20**	
1 - Assume 1.6 tons sand per yd^3					
2 - Assume 20% decompression factor					

Table D-3

Site 32 Alternative 3: Extended Phytoremediation Barrier

POP assumed 30 months

	Unit Price	Unit	Units	Extended Cost	Source
Project Management/Monthly Reporting**	$2,200.00	mo	30	$66,000.00	Engineering Estimate
Meetings	$2,000.00	ea	10	$20,000.00	Engineering Estimate
Data Management	$30,000.00	LS	1	$30,000.00	Engineering Estimate
SUBTOTAL				$116,000.00	
Field Task 1 - Phyto-planting	Unit Price	Unit	Units	Extended Cost	Source
Weather Station procurement	$8,000.00	LS	1	$8,000.00	Engineering Estimate
Willow Trees (purchase/delivery/maintenance)	$61.00	ea	360	$21,960.00	Vendor Quote
Fencing (8-ft chain-link)	$52,160.00	LS	1	$52,160.00	Vendor Quote
Labor and oversight	$1,200.00	day	20	$24,000.00	Engineering Estimate
SUBTOTAL				$106,120.00	
Field Task 2 - Well Installations	Unit Price	Unit	Units	Extended Cost	Source
Permitting	$2,500.00	LS	1	$2,500.00	Engineering Estimate
Monitoring Well Installation/Develop	$4,500.00	ea	10	$45,000.00	Engineering Estimate
IDW Removal (per well)	$540.00	ea	10	$5,400.00	Engineering Estimate
IDW Analytical (per well)	$300.00	ea	10	$3,000.00	Engineering Estimate
Micropurge Pump + Install	$2,650.00	ea	10	$26,500.00	Engineering Estimate
Surveying	$200.00	ea	10	$2,000.00	Engineering Estimate
Labor and Oversight	$1,500.00	day	20	$30,000.00	Engineering Estimate
SUBTOTAL				$114,400.00	
Field Task 3 GW Monitoring and Reporting	Unit Price	Unit	Units	Extended Cost	Source
Monitoring	$8,085.00	LS	5	$40,425.00	Table D-4
Reporting	$13,030.00	LS	3	$39,090.00	Table D-5
SUBTOTAL				$79,515.00	
Closeout Report	$35,000.00	LS	1	$35,000.00	
SUBTOTAL				$451,035.00	
20% contingency				$90,207.00	
TOTAL PROGRAM				**$541,242.00**	

Table D-4

Site 32 IRA Quarterly Groundwater Monitoring Event - 10 New Wells

For Alternatives 2a, 2b, and 3

Item	Unit Price	Unit	Units	Extended Cost
Labor				
Engineering Technician (field)	$750	day	4	$3,000
Geologist - Jr Level (field)	$900	day	1	$900
Hydrogeologist - Senior Level	$1,100	day	0.5	$550
Project Manager	$1,300	day	0.5	$650
SUBTOTAL				$5,100
Equipment	Unit Price	Unit	Units	Extended Cost
Field truck	$50	day	2	$100
Monitoring instruments	$100	day	4	$400
Phone	$5	day	2	$10
SUBTOTAL				$510
Materials	Unit Price	Unit	Units	Extended Cost
Sampling Supplies	$100	LS	2	$200
Fed-Ex	$60	ea	2	$120
SUBTOTAL				$320
Subcontracts	Unit Price	Unit	Units	Extended Cost
Analytical	$100	ea	11	$1,100
SUBTOTAL				$1,100
QUARTERLY SUBTOTAL				$7,030
15% Management & Administration Contingency				$1,055
PROJECT TOTAL				**$8,085**

Table D-5

Site 32 Groundwater Monitoring Report

Item	Unit Price	Unit	Units	Extended Cost
Labor				
Engineering Technician	$560	day	7	$3,920
Geologist - Mid Level	$700	day	5	$3,500
AutoCAD/Graphics	$480	day	2	$960
Hydrogeologist - Senior Level	$900	day	2	$1,800
Project Manager	$1,000	day	1	$1,000
SUBTOTAL				$11,180
Equipment	Unit Price	Unit	Units	Extended Cost
Computer Use	$5	day	4	$20
SUBTOTAL				$20
Materials	Unit Price	Unit	Units	Extended Cost
Photocopies	$0.07	pg	1000	$70
Fed-Ex	$15.0	ea	4	$60
SUBTOTAL				$130
SUBTOTALS				$11,330
15% Management & Administration Contingency				$1,700
PROJECT TOTAL				**$13,030**

E RESPONSE TO STATE REGULATORY COMMENTS

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C155-1069
T99062-05

3 January 2005

Ms Kathleen Gerber
Department of the Air Force
AFCEE/ICS
806 13th Street, Suite 116
Vandenberg AFB, CA 93437

Subject: Response to Comments from the Regional Water Quality Control Board, dated 6 December 2004 on the Draft Site 32 Cluster Removal Action Work Plan

Reference: Contract No. F41624-03-D-8617, Task Order: 0062

Dear Ms. Gerber:

On behalf on the Department of the Air Force, Tetra Tech, Inc. is submitting the Response to Comments from the Regional Water Quality Control Board dated 6 December 2004 on the Draft Site 32 Cluster Removal Action Work Plan (RAW). Copies are also being provided to the Regional Water Quality Control Board (RWQCB) and the Department of Toxic Substances Control (DTSC). These responses will be incorporated into the Draft Site 32 Cluster RAW in preparation for the Draft Final Site 32 Cluster RAW.

If you have any questions or concerns regarding this matter, please feel free to contact David Springer or Matt Houlahan at (805) 681–3100, extensions 113 and 140, respectively, by Fax at (805) 681-3108, or by email at david.springer@tetratech.com or matt.houlahan@tetratech.com, respectively.

Sincerely,

TETRA TECH, INC.

David Springer, R.G. No. 6962
Principal Hydrogeologist

TETRA TECH, INC.

Matt Houlahan
Geologist I

cc:

Stone, L. (RWQCB)
Meece, W. (RWQCB)
Than, Q. (DTSC)
Kephart, B (VAFB IRP)
MacLelland, R (VAFB IRP)
Atta, A. (VAFB IRP)
McNamara, K. (Tt-SBA)
Liu, S. (Tt-LAF)
99062 File

1.0 RESPONSES TO COMMENTS FROM THE REGIONAL WATER QUALITY CONTROL BOARD DATED 6 DECEMBER 2004 ON THE DRAFT SITE 32 CLUSTER REMOVAL ACTION WORK PLAN

1.1 GENERAL COMMENTS

General Comment 1: Site 35 Treatability Study, Selection of Substrate

The RAW does not state why soybean oil was selected over other substrates (e g., molasses, which was the substrate in the demonstration project at this site cluster). The text should describe the rationale for selecting soybean oil, potential problems with the selected substrate, and how these problems will be identified and rectified. Based on a literature review, some potential problems with the use of a vegetable oil substrate are:

- Decreased permeability of the aquifer as a result of oil clogging the pore spaces. Decreased permeability at the injection barrier can cause a plume to migrate around the barrier.
- Limited distribution. Low injection pressures can result in preferential distribution in the upper injection zone, with little or no oil reaching the lower zone. High injection pressures can create preferential pathways through aquifer fracturing.
- Achieving the optimal emulsion for distribution in the aquifer. How will the appropriate composition and oil droplet size be determined and achieved?
- Degradation of vegetable oil to methane. Because vegetable oil can degrade directly to methane, there is a potential hazard from the accumulation of explosive concentrations in buildings and subsurface features (e.g., monitoring and injection wells).
- Incomplete dechlorination, resulting in the accumulation of daughter products. This is a potential problem with any remedial system based on enhanced dechlorination

Air Force Response:

The RAW is presented as an integration of three activities to be performed at Site 32 Cluster; one, a Hydropunch investigation designed to further characterize the nature and extent of contamination at Site 32 and Site 35; two, an interim removal action (IRA) involving phytoremediation at Site 32; and three, a treatability study at Site 35 in the vicinity of 35-MW-8 designed to evaluate the efficacy of injecting an emulsified soybean oil substrate into a portion of the Site 35 aquifer to promote the reductive dechlorination of TCE and its daughter products. The treatability study, as outlined in this work plan, is not subject to evaluation by the nine National Contingency Plan (NCP) evaluation criteria. The treatability study is designed to evaluate the success of a new technology. Emulsified soybean oil was selected as a substrate due to its suitability with site characteristics. The shallow groundwater, the relatively small size of the contaminant plume, the lack of infrastructure in the vicinity of the contaminated area, evidence of ongoing slow or stalled reductive dechlorination, the aquifer characteristics (i.e., organic carbon content, hydraulic conductivity, etc.), as well as the concentration of sulfate present at the targeted treatment zone are all factors contributing to the selection of emulsified soybean oil as the proposed substrate.

Potential problems may arise when injecting emulsified soybean oil, as stated in the comments from the RWQCB. Each potential problem mentioned is addressed in a separate bullet.

- The potential problem of decreased permeability of the aquifer resulting in oil clogging of the pore spaces may be avoided by following guidance outlined in *Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents*, Air Force Center for

Environmental Excellence [AFCEE] August 2004. Emulsified soybean oil is to be injected as opposed to "neat" or undiluted oil. By reducing the oil droplet diameter size to about one micron (suitable for fine-grained sands and silts), clogging will be dramatically reduced.

- Limited distribution of the substrate will be avoided by using an emulsified soybean oil substrate and by applying the correct pressure needed to evenly distribute the soybean oil substrate without causing preferential pathways. The pressure is not expected to exceed the overburden pressure, as the substrate is a low viscosity fluid.
- The appropriate oil composition will be achieved by analysis of the benchscale test results The anticipated composition of the substrate solution will most likely follow guidance as outlined in *Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents*, AFCEE August 2004; 5 to 10 percent by volume oil and emulsifier will be mixed with 90 to 95 percent of groundwater collected from Site 35.
- The degradation of vegetable oil is not expected to produce methane at concentrations above the lower exposure limit (LEL). However, to address the concerns of the RWQCB, during site activities methane concentrations will be monitored using a flame ionization detector (FID). If concentrations exceed action limits set forth in the site specific health and safety plan, appropriate action will be taken. In addition, stoichiometric equivalent volumes will be calculated prior to substrate injection in order to predict future concentrations of methane.
- Incomplete dechlorination, resulting in the production and potential accumulation of daughter products is a potential scenario for all microbially mediated sequential chemical reactions. It will be avoided by close monitoring of water parameters and analyses (dissolved oxygen, oxidation reduction potential, pH, chloride, sulfate, nitrate, alkalinity, sulfide, and total organic content) to ensure that an anaerobic environment is maintained. Proper guidance will be followed to achieve this goal.

General Comment 2: Site 35 Treatability Study Design

The RAW does not provide enough information on the system's design for either regulatory review or field implementation. If some specific design components will be based on the results of the benchscale test, the RAW should specify these parameters and state how this information will be conveyed to the regulators and field team. Where will the benchscale test design be presented and what are the intended outputs? Will a microbial study be conducted to determine if the appropriate in-situ organisms are present? The oil droplet size relative to the mean pore-throat diameter is a critical design parameter that must be considered. What test criteria will be used to determine the suitability of the proposed remedial system (e.g., absence of appropriate in-situ microorganisms, low permeability, high organic content, etc)? How will the required mass of substrate, dosage rate, injection pressure, and optimal residual saturated be determined? Also, please note, we will require the chemical composition of the ejectate solution (i.e., oil, emulsifier, "primer" and water) prior to granting approval for implementation of the treatability study. The injectate components could contain impurities or additives that may have unanticipated impacts on water quality or hydraulic properties of the aquifer. The RAW should describe any lessons-learned from the previous demonstration study (e.g., injection rates, clogging problems, incomplete dechlorination, radius of influence, travel time, and low pH causing mobilization of metals). This information could be very helpful in designing the system and developing appropriate performance standards. Also see our comments on the prior demonstration study (Attachment 1).

Air Force Response:

Information on the design of the treatability study will be obtained through the benchscale test. The objective of the test is to determine if addition of emulsified soybean oil will enhance the degradation of TCE under anaerobic conditions. The benchscale program will consist of three different tests described below. Native soil and groundwater from the site will be collected during the Hydropunch investigation and used in each of the three tests to support the benchscale program. The first test will utilize native soil and groundwater spiked with TCE at a concentration of 5,000 micrograms per liter (µg/L). No emulsified soybean oil will be added to this batch; it will be used as a control. The second test will utilize native soil and groundwater spiked with TCE at a concentration of 5,000 µg/L, with the addition of an emulsified soybean oil substrate. The substrate will be comprised of 10 percent soybean oil and emulsifier by volume with a droplet size of approximately one micron mixed with 90 percent native groundwater by volume. The third test will utilize the same variables as the second test with the addition of *Dehalococcoides ethenogenes*. These three tests will be monitored by the subcontractor and a report will be generated showing the effects of emulsified soybean oil and *Dehalococcoides ethenogenes* on the degradation of TCE under anaerobic conditions. The findings of the test will be applied to further delineate unknown variables (such as required mass of the substrate, the dosage rate, and the injection pressure) of the treatability study. A second paragraph will be added to Section 6.4.2.1 of the RAW to describe the benchscale objectives, inputs, and outputs in more detail. In addition, a chemical composition of the substrate and its components as well as lessons learned from previous demonstration projects (i.e., the ARCADIS study using molasses) will be outlined in Section 6.4.2.

- No General Comment 3 provided. -

General Comment 4: Performance Standards

The RAW should present appropriate performance standards for the selected alternatives. The following documents could be useful in this effort.

- *Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents*, Air Force Center for Environmental Excellence [AFCEE] August 2004 (http://www.afcee.brooks.af.mil/products/techtrans/bioremediation/downloads/PrinciplesandPractices.pdf).
- *Remediation Process Optimization*, Interstate Technology & Regulatory Council, September 2004 (http://itrcweb.org/RPO-1.pdf).
- *Phase II Field Feasibility Test for In-situ Bioremediation of Chlorinated Solvents Via Vegetable Oil Injection, Travis Air Force Base*, AFCEE, February 2002 (http://www.afcee.brooks.af.mil/products/techtrans/bioremediation/downloads/travisfinalsitess015phaseiiworkplan.pdf).

An example of an issue that should be considered in the performance evaluation is differentiating between degradation and adsorption of CAHs. Since CAHs have a greater affinity for dissolution into the oil phase relative to the aqueous phase, some decrease in CAHs will be attributable to partitioning into oil. Therefore, the performance evaluation should be able to differentiate between adsorption versus actual degradation. This may require analysis of the oil fraction in injection wells. Also consider our comments on the prior demonstration study regarding data presentation and interpretation (Attachment 1).

Air Force Response:

The RAW will incorporate performance standards as appropriate in Section 6.4.3.1, Treatability Study Data Interpretation. The above referenced documents will be reviewed and appropriate considerations regarding the comparability of data collected from the treatability study will be documented.

Comparisons of historical trends with future data, comparison of upgradient well data to treatment zone wells, stoichiometric equivalents representing parent and daughter products, and awareness of detection limits in pre and post injection sample analyses will aid in the comparability of data. In addition, a discussion of the potential for a decrease in CAHs due to adsorption rather than degradation and the related possibility of an oil fraction analysis will be included in the treatability study data interpretation.

General Comment 5: Appendix B, Applicable, Relevant and Appropriate Requirements (ARARs)

We suggest that the Air Force designate one document (e.g., Management Action Plan) as the general reference for facility-wide ARARs The discussion of ARARs in site documents could then be limited to site or action-specific ARARs. This approach would expedite document review and ensure that all appropriate agencies have an opportunity to review the ARARs Please note that ARARs in Appendix E of the current Management Action Plan (Final Revision 9, August 2004) need to be expanded as discussed in our October 21, 2004 State (Regional Board and DTSC) letter Also see Specific Comment 13.

Air Force Response:

Comment noted The ARARs listed in the Site 32 Cluster RAW are chemical, location, and action specific.

1.2 SPECIFIC COMMENTS

Specific Comment 1: Section 3, Technical Approach and Investigation Findings

We noted that several sections of the text state that detected metals (e.g., potassium and sodium) are "essential human nutrients." Since many metals can be considered essential human nutrients, but can also have toxicity effects at higher concentrations (e.g., selenium), we suggest that metals be discussed in terms of toxicity rather than nutritional value.

Air Force Response:

The RAW will discuss detected metals in terms of toxicity.

Specific Comment 2: Section 4.1.1, Source and Extent of Groundwater Contamination

Please include the cited trend analysis or reference the document that reports the analysis.

Air Force Response:

The *Draft Basewide Groundwater Monitoring Program Annual Report* dated 19 November 2004 will be referenced in Section 4.1.1.

Specific Comment 3: Section 4.1.1, Source and Extent of Groundwater Contamination

See Attachment 1 regarding the discussion of degradation and daughter products.

Air Force Response:

Comment noted. Attachment 1 outlines regulator concerns regarding the evaluation of parent and daughter products, most notably, the necessity for contamination comparison on a molar basis. This comment will be incorporated into the technical reports produced throughout the duration of the treatability study project.

Specific Comment 4: Section 4.1.1, Source and Extent of Groundwater Contamination

The information referenced as contained in Section 3.4 of the RAW is actually in Section 3.3.

Air Force Response:

Comment noted. The appropriate section of the RAW will be referenced.

Specific Comment 5: Section 6.1.3, Site 35 Treatability Study

Please qualify the statement regarding the success of the demonstration project in accordance with relevant comments in Attachment 1.

Air Force Response:

The demonstration project will be qualified as having demonstrated that anaerobic conditions can be successfully induced in the aquifer at Site 35, with evidence of at least partial reductive dechlorination in several monitoring wells.

Specific Comment 6: Section 6.1.1, Sites 32 and 35 Supplemental Groundwater Investigation

Please specify how the results of the fate and transport modeling and selected study location will be documented and submitted for regulatory review.

Air Force Response:

The results of the fate and transport modeling and selected study location will be documented and submitted for regulatory review as outlined in Section 6.2.5. Within the bullets outlined in this section, the Air Force will include the screened intervals of the proposed monitoring wells at Site 32 and Site 35, as well as provide a revised conceptual site model as an appendix in the groundwater investigation report.

Specific Comment 7: Section 6.2, Sites 32 and 35 Groundwater Investigation

A goal of the investigative effort should be to determine whether there is vertical concentration gradient for CAHs. If CAHs are present in the form of dense non-aqueous liquids (DNAPL), we would anticipate highest concentrations near bedrock and lowest concentrations near the top of the saturated zone. If a vertical gradient is present, the remedial effort and performance monitoring should target the zone with the highest concentrations.

Air Force Response:

Sufficient data have been collected at this site to demonstrate that CAHs are at highest concentrations towards the bottom of the saturated zone of groundwater occurrence. As shown in Figure 3.3-1 of the

RAW, all discrete depth groundwater samples collected from both the top and bottom of any given location (i.e., 35-P-9, 35-B-9, and 35-P-5) during Phase II of the RI reveal higher concentrations of CAHs in the bottom of the saturated zone. In addition, as outlined in Table 6.2-1, the Hydropunch investigation samples will be gathered in places of potential DNAPL occurrence, such as near the discharge points of former drainage channels. The treatability study and performance monitoring, based on historical and future data gathered, will be performed in the zone with the highest concentrations.

Specific Comment 8: Section 6.2.1, Design of Hydropunch Investigation

How will the field team determine when they have encountered bedrock? Please note, hydropunch investigations at Site 15 misidentified several bedrock contacts. This misidentification led to underestimation of the extent of the plume.

Air Force Response:

The field team will determine when they have encountered bedrock during drilling activities with routine core inspections, correlations with historic boring logs, and recognition of refusal. At Site 35, the bedrock contact is often distinguished by a 1 to 2 foot thick clay zone that represents the upper weathered surface of the Sisquoc Formation (see boring logs 35-MW-3, 35-MW-6, 35-MW-7 and 35-MW-8 in the Draft Final RI). In addition, the bedrock beneath Site 35 forms a monocline, which is significantly different than the undulating bedrock surface beneath Site 15

Specific Comment 9: Section 6.4.2.2, Soybean Injection Process

We suggest that an inert tracer, such as bromide, be included in the injectate for performance monitoring purposes.

Air Force Response:

Comment noted. Bromide will be included in the substrate solution to be used as an inert tracer to further profile the injectate migration pattern.

Specific Comment 10: Section 6.4.2.2, Soybean Injection Process

What is the basis for the proposed injection well spacing?

Air Force Response:

The basis for proposed well spacing of between 10 to 20 feet, as mentioned in Section 6.4.2.4, resulted from the lack of distribution of substrate achieved by ARCADIS during the molasses injection. Gaps of IRZ influence existed downgradient of injection wells 35-I-2 and 35-I-3 approximately 14 months into operation of the IRZ project in April 2002 (see Attachment 1). In addition, as mentioned on Table 5.1 on page 5-7 of *Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents*, AFCEE August 2004, a well spacing of between 5 and 15 feet between injection point centers is recommended. In light of the ARCADIS data and AFCEE guidance, a well spacing of between 10 and 20 feet was determined; with likely well spacing closer to 10 feet

Specific Comment 11: Section 6.4.2.5, Injection Well Installation

If the study will consist on a single injection, why does the RAW propose installing permanent injection wells rather than using borings? Why does the RAW propose flush-mounted surface completions? Above ground completions offer more protection against surface contamination and are less likely to be covered by vegetation or sand.

Air Force Response:

The RAW proposes installing permanent injection wells for the purpose of potential expansion of the treatability study into later remedial phases. Permanent wells will also limit future injection costs. Regarding the well completion comment, the RAW will be revised to replace flush-mounted surface completions with above ground surface completions for the injection wells.

Specific Comment 12: Section 6.4.2.5, Monitoring Well Installation

The screened intervals for monitoring wells should be as short as possible and still achieve project objectives. Please note that based on the results of the investigation effort, it may be necessary to screen specific discrete zones or install nested wells. See Specific Comment 7 regarding selection of screened interval.

Air Force Response:

Comment noted. Data collected during the investigation phase of the project will be used to determine the appropriate screened interval for future monitoring wells. As previously noted, the targeted injection interval will correspond to the zone of highest groundwater VOC concentration.

Specific Comment 13: Appendix B, Applicable, Relevant and Appropriate Requirements

The ARARs in Appendix B are generally consistent with current Regional Board ARARs. Please make the following edits to the items as numbered in Appendix B.

9. Please expand the discussion under Comments as follows: "The Basin Plan for RWQCB CCR assigns the beneficial use of drinking water to all groundwater in the region (with the exception of the Soda Lake sub-basin). The Basin Plan supercedes Resolution 88-63, therefore, the beneficial use of drinking water must be protected regardless of the Resolution's criteria."
10. Please correct "Discharge' as the beginning of the second sentence under "Description."
11. Please delete this item since it redundant with Item 9.

All appropriate agencies that did not receive the RAW (e.g., U.S. Department of Fish and Game and Santa Barbara County) should also have an opportunity to review and comment on the ARARs.

Air Force Response:

Comment noted. ARARs 9, 10, and 11 will be revised as stated above in Specific Comment 13. The Air Force will await direction from the DTSC RPM on the ARARs issue. Please note that the Draft Final RAW will be available in its entirety for public review.

Attachment 1

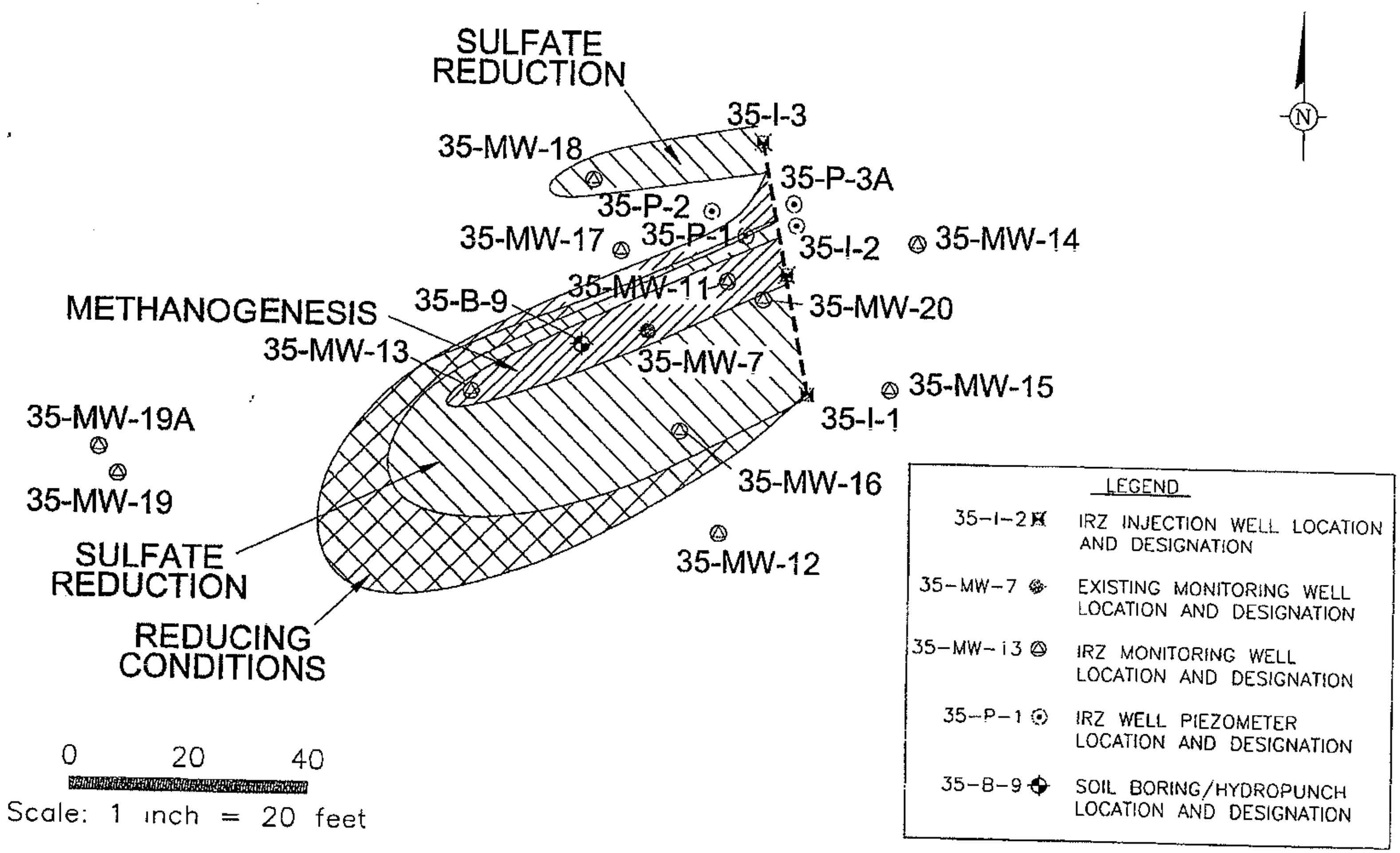

Figure 4-16. Redox Zone Map for April 18, 2002 (After 14 Months of Active Treatment)

C155-1113
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18 January 2005

Ms. Kathleen Gerber
Department of the Air Force
AFCEE/ICS
806 13th Street, Suite 116
Vandenberg AFB, CA 93437

Subject: Response to Supplemental Comments from the Regional Water Quality Control Board via an Electronic Transmittal, dated 4 January 2005 on the Draft Site 32 Cluster Removal Action Work Plan

Reference: Contract No F41624-03-D-8617, Task Order: 0062

Dear Ms. Gerber:

On behalf on the Department of the Air Force, Tetra Tech, Inc. is submitting the attached responses to Supplemental Comments issued by the Regional Water Quality Control Board via an electronic transmittal dated 4 January 2005 on the Draft Site 32 Cluster Removal Action Work Plan (RAW). Copies are also being provided to the Department of Toxic Substances Control. These responses will be incorporated into the Draft Final Site 32 Cluster RAW.

If you have any questions or concerns regarding this matter, please feel free to contact David Springer or Matt Houlahan at (805) 681–3100, extensions 113 and 140, respectively, by Fax at (805) 681-3108, or by email at david.springer@tetratech.com or matt.houlahan@tetratech com, respectively.

Sincerely,

TETRA TECH, INC.

David Springer, R.G. No. 6962
Principal Hydrogeologist

TETRA TECH, INC.

Matt Houlahan
Geologist I

cc:

Stone, L. (RWQCB)
Meece, W. (RWQCB)
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Atta, A. (VAFB IRP)
McNamara, K. (Tt-SBA)
Liu, S. (Tt-LAF)
99062 File

1.0 RESPONSES TO SUPPLEMENTAL COMMENTS FROM THE REGIONAL WATER QUALITY CONTROL BOARD ELECTRONIC TRANSMITTAL DATED 4 JANUARY 2005 ON THE DRAFT SITE 32 CLUSTER REMOVAL ACTION WORK PLAN

1.1 GENERAL COMMENTS

Supplemental RWQCB General Comment 1:

The response discusses how clogging will be minimized, but does not state what monitoring will be conducted to confirm there are no clogging problems (e.g., groundwater elevation data, gradient, COCs distribution).

Air Force Response:

The following text will be added to Section 6.4.2.2 of the Draft Site 32 Cluster RAW:

Due to the use of an emulsifier and magnitude of dilution of the soybean oil, the potential for clogging will be minimized (AFCEE 1994) However, to evaluate this potential, the targeted portion of the aquifer will be evaluated by monitoring indicators associated with hydraulic conductivity in the treatment zone. A baseline aquifer slug test will be conducted to provide a background hydraulic conductivity for two wells (to be assigned after installation of the injection and monitoring wells) within the study area. The groundwater elevation will be closely monitored throughout the project in the injection wells and nearby monitoring wells to assess whether groundwater mounding (an elevation in the water table) persists following injection. Initial mounding is expected, as a relatively large volume of substrate will be introduced to the aquifer. If persistent mounding is present, indicating potential clogging problems, a second aquifer test will be completed. The hydraulic conductivity results will be compared to the baseline results to assess the potential presence and magnitude of clogging, if present

Supplemental RWQCB General Comment 4:

The response states that performance standards will be provided in the revised report We believe clear performance standards are an important part of any test of a remedial system and look forward to reviewing them in the revised document.

Air Force Response:

The following text will be added to Section 6.4.1 of the Draft Site 32 Cluster RAW:

Performance standards will provide key insight as to the overall effectiveness of the ESO injection process to induce an anaerobic environment favorable for reductive dechlorination. Essential transitions must occur in order for the environment to be suitable for degradation of chlorinated solvents. Key indicators are outlined as the following:

- Concentrations of the parent compound (TCE) are reduced;
- Dechlorination product (*cis*-1,2-DCE, *trans*-1,2-DCE, or vinyl chloride) concentrations are increased and do not demonstrate a buildup;
- Ethene and/or ethane is produced, even if in low concentrations;
- Metabolic transformation products are present (e.g. pyruvic, butyric, propionic acids);

- Total organic carbon (TOC) concentrations measurably increase above background indicating aquifer loading;
- Dissolved oxygen concentrations are less than 0.5 mg/L and ORP values are less than 0.0 mV; preferably in the -150 to -250 mV range;
- An increase in Fe(II) concentrations is observed with a reduction in competing electron acceptors (e.g. nitrates, sulfate, etc.);
- Methane is produced, indicating that fermentation is occurring and that the potential for complete dechlorination exists.

The indicators listed above form the performance standards that will be evaluated throughout the duration of the treatability study. These are designed to provide overlapping lines of evidence of the creation of reducing conditions in the targeted treatment zone and the resultant breakdown of TCE and its daughter products. Ultimately, the persistent decline of contaminant concentrations will provide the strongest evidence supporting the effectiveness of enhanced anaerobic bioremediation.

1.2 SPECIFIC COMMENTS

Supplemental RWQCB Specific Comment 3:

We look forward to reviewing the evaluation that will be included in the revised text.

Air Force Response:

The following text will be added to Section 4.1.1 of the Draft Site 32 Cluster RAW:

Nineteen additional monitoring wells/points (Figure 3.4-1) have been installed by ARCADIS in support of their demonstration project. These wells are positioned in the vicinity of well 35-MW-7. Historic groundwater monitoring data from these wells is summarized in Table 3.4-1. Review of this table indicates that TCE and its degradation daughter products *cis*-1,2-DCE and vinyl chloride have been detected in selected ARCADIS monitoring wells. It is noted that due to differences in sampling techniques used by ARCADIS (e.g. Hydrosparge grab samples, submersible pumps, etc.) compared to methods employed during the BGMP (i.e. MicroPurge Sampling), as well as temporal differences in sampling dates, there exists some difference in VOC concentrations reported between the ARCADIS data, particularly for well 35-MW-7 (Table 3.4-1), and the BGMP reported data (Figure 3.3-2).

The baseline monitoring event completed by ARCADIS in November 2000 was characterized by relatively high detection limits for *cis*-1,2-DCE and vinyl chloride rendering comparison of subsequent monitoring data against baseline data to be somewhat limited. Also, approximately one half of ARCADIS' monitoring points were grab samples, where only a single data point is available; these data were presumably used to fine tune positioning of permanent monitoring wells. Collectively, the ARCADIS data provides additional documentation of chlorinated VOC presence in groundwater near well 35-MW-7, but do not demonstrate a significantly larger groundwater plume.

The following text will be added to Section 3.3 of the Draft Site 32 Cluster RAW:

Notable ARCADIS wells that demonstrate TCE presence above 1,000 µg/L at least once following baseline monitoring include wells 35-MW-12, 35-MW-15, 35-MW-16, 35-MW-17, and 35-MW-19A. Over the course of the demonstration project, TCE was shown to decline in each of these wells; accompanied by a presence or increase in *cis*-1,2-DCE. In wells 35-MW-16 and 35-MW-19A, *cis*-1,2-DCE concentrations increased from a low of 18 to a high of 450 µg/L, and from 38 to 250 µg/L, respectively, over the course of the demonstration program Vinyl chloride was detected from three wells in the May 2003 sampling event only at concentrations ranging from 0.28J to 26 µg/L (Table 3.4-1).

Using well 35-MW-16 as an example, the change in concentration between baseline sampling (1,600 µg/L) and the end of project sampling in May 2003 (410 µg/L), represents a decline in 1,190 µg/L. On a stoichiometric basis, expressed in molar equivalents, a change in TCE of 1,190 µg/L represents 9.06 micromoles TCE per liter (µM TCE/L). *Cis*-1,2-DCE increased in the same well over the course of the project by 419 µg/L; which equates to a molar equivalent of 4.32 µM DCE/L For vinyl chloride, a single detection of 26 µg/L at the end of the study would correspond to a molar equivalent of 0.42 µM VC/L. Ethene did not change significantly over the source of the study in this well. Thus, a little over one half of the TCE decline in well 35-MW-16 can be associated with a rise in DCE and VC over the course of the study.

RESPONSES TO COMMENTS FROM THE DEPARTMENT OF TOXIC SUNSTANCES CONTROL DATED 23 DECEMBER 2004 ON THE DRAFT SITE 32 CLUSTER REMOVAL ACTION WORK PLAN

DTSC Comment 1:

The title of the document should be changed to Draft Removal Action Work Plan for Interim Removal Action at IRP Site 32 Cluster.

Air Force Response:

The title of the document will be changed to that indicated above.

DTSC Comment 2:

Executive Summary:

a. Provide a statement that the Removal Action Work Plan follows DTSC remedy selection process for hazardous substances release sites, pursuant to California Health and Safety Code Section 25356.1

b. Provide an explanation why the response action is for groundwater only and provide information regarding soil contamination and evaluation of soil risk at the site.

c. Provide a statement that the proposed interim removal action (IRA) remedy is compatible with the final remedies of Site 32 Cluster. Since institutional controls (ICs) are a component of the remedy (no current plan to use groundwater as potable water source now or in the future), please include a statement that ICs are considered a remedy in accordance with California Health and Safety Code Sections 25316 and 25260 and that VAFB will submit a Feasibility Study/Remedial Action Plan (RAP) to document the final remedy for Site 32.

Air Force Response:

a. A statement that the Removal Action Work Plan follows DTSC remedy selection process for hazardous substances release sites, pursuant to California Health and Safety Code Section 25356.1 will be included in the Executive Summary.

b. The following explanation will be included in the Executive Summary: The focus of the IRA is for interim remediation of groundwater only. The Draft Final Remedial Investigation dated June 2004 concludes that the results of the human health risk assessment indicate acceptable risks for industrial workers, construction workers, and visitors exposed to COPCs in soils Similarly, ecological risks stem from hypothetical exposures to groundwater only. Therefore, the interim response action is for groundwater only because soil does not pose a significant human health or ecological risk at the site.

c. A statement will be included in the Executive Summary indicating the proposed IRA is compatible with final remedies at the site. In addition, a statement will be included indicating that ICs are considered a component of the remedies evaluated in accordance with California Health and Safety Code Sections 25316 and 25260. Institutional controls will be included in the Feasibility Study/Remedial Action Plan, as a remedy component considered for the site.

DTSC Comment 3:

Section 2.2. Environmental Settings: The project approval is subject to California Environmental Quality Act (CEQA) We request the following information for the preparation of CEQA documents

a 2.2.3 Geology: Provide information regarding fault zones in the area and evaluate the impact of seismicity

b. 2 2 4 Hydrology: Please describe to what extent project activities:

i Would violate any water quality standards or waste discharge requirements.

ii Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficient in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).

iii. Substantially alter the existing drainage pattern of the site or area, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on or offsite.

iv. Otherwise substantially degrade water quality.

c. 2 2 5 Ecological Resource: Provide an analysis of potential impact of the IRA on endangered, listed, or threatened species at the site and mitigation measures to reduce impact of the proposed project

d. 2.2.7 Cultural Resources: The document indicates that the 30th Civil Engineer Squadron Environmental Flight was contacted in 2001 to determine if cultural resources were identified at Site 35. What was the outcome of the contact? Please include revisions in the document to indicate that items of interest such as bones, fossils, or human artifacts of potential historical significance if uncovered during construction of the remedy, a paleontologist or archaeologist will be contacted and field work will resume after all necessary natural resources protective actions are taken.

e. Mineral Resources, Utilities, Transportation and Traffic: Provide an estimate of the natural resource that will be consumed by the project, number of trucks hauling waste, vehicles, traffic flow, loading and transport of wastes, traffic control measures, and duration of project activities.

Air Force Response:

DTSC Comment 3 has several subparts that are related to CEQA issues; it is not clear whether these are appropriate to include such discussion in the RAW for the proposed IRA. State regulatory comments and Air Force responses to these comments, as provided below, are proposed to be included in a new Appendix E to the Draft Final and Final RAW, instead of being incorporated into the text of the document This approach should help maintain the streamlined nature of the document allowing a more readable RAW for the public, while at the same time providing DTSC technical information that will support the preparation of CEQA documents.

3a

Due to proximity of known active faults to the project area, the project site is classified as being located in a seismically active area However, since the proposed "construction" activities are limited to installation of groundwater remediation and monitoring wells and planting of trees, the impact of potential seismic activity is anticipated to present no significant threat on project activities. A seismic evaluation is provided below.

Active and potentially active faults in the Site region were evaluated by reviewing the *Fault Activity Map of California and Adjacent Areas* (Jennings 1994) and *Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada* (International Conference of Building Officials [ICBO] 1998) Table 1 is a summary of the data on active faults located up to 100 kilometers (km) from the Site that are presented in *Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada* (ICBO 1998) as determined by the computer program, UBCSEIS, Version 1.03 (Blake 1999).

The terms "active" and "inactive" have been interpreted differently by geologists, seismologists, and agencies. For this assessment, active faults are defined as having evidence of surface displacement within the last 11,000 years and potentially active faults are defined as having evidence of surface displacement in the last 1.6 million years (ICBO 1998). Active Faults-Near-Source Zones identified in the Site area, as defined in ICBO 1998, include the Lion's Head fault, approximately 1.7 km northeast of the Site; the Casmalia 4.5 km northeast, the Hosgri 112.7 west, the San Luis Range (south margin) 21.6 km northeast, and the Los Alamos-Baseline fault, approximately 23 km northeast. All of these faults are considered Type B active faults (defined as faults with maximum moment magnitudes (Mmax) greater than 7 and slip rates less than 5 millimeters per year (mm/yr), or with Mmax less than 7 and slip rates greater than 2 mm/yr, or with Mmax greater than 6.5 and slip rates greater than 2 mm/yr (ICBO 1998). The nearest Type A active fault (defined as faults with Mmax greater than 7 and slip rates greater than or equal to 5 mm/yr) is the San Andreas-1857 Rupture segment, located approximately 84 km from the Site.

A summary of the California Geological Survey (CGS) historical earthquake record for the Site area from 1800 through 2000 as estimated by the computer program EQSEARCH (Blake 2000) is summarized in Table 2. As shown in Table 2, the earthquake reoccurrence interval for the last 200 years based on the CGS database ranged from once every 1.78 years for M_L 4.0 earthquakes to once every 100.5 years M_L 7.5 earthquakes. Historical earthquakes that originated in the Santa Maria region include the Los Alamos earthquakes of 1902 and 1915 (Richter Magnitudes [M_L] 5.4 and 5.2, respectively), the 1916 Avila Beach earthquake (M_L 5), the 1927 Lompoc earthquake (M_L 7.0), and the 1980 Point Sal Earthquake (M_L 5.1). While all of these earthquakes were felt in the Site area, no historical earthquakes have caused a great amount of property damage or loss of human life in the Site area.

Surface fault rupture hazards for the Site area were evaluated through examining Special Study Zone Maps created under the Alquist-Priolo Earthquake Fault Zoning Act (AP Act). The AP Act addressees the seismic hazard of surface fault rupture and prohibits the placement of structures across traces of active faults. Under the AP Act, Special Study Zone Maps are created to delineate special AP Zone Fault Zone study areas around known active faults. There are no Special Study Zone Maps for the Site area, and no known active faults extend across the Site. The closest AP

Zone Fault Zone to the Site is along the Los Alamos-Baseline fault, approximately the 23 kilometers to the northeast.

Potential structural damage from landslides and tsunamis are related to regional seismic activity. The Site is in an area of horizontal to gently sloping topography and no landslides have been identified at the Site. Therefore, landslides are not considered to be a potential hazard. Tsunamis are large and destructive waves in the ocean caused by seafloor movement from earthquakes and landslides. In the event of a tsunami reaching the coast of Vandenberg AFB, it is not likely that the Site would be affected due to its surface elevation and distance from the Pacific Ocean (approximately 400 feet above msl and 3 miles, respectively)

Liquefaction is related to regional seismic activity. It is the significant loss of soil strength due to pore pressure increase from ground shaking which reorients unconsolidated sediment grains into a more compact arrangement. If the water table is close to the surface during this reorientation, the grain-to-grain contacts are reduced and the load is temporarily transferred to the pore water. This increases pore pressure, decreases the strength, and the deposit then behaves like a liquid. Liquefaction may occur when groundwater is present at depths less than 50 feet bgs within the potentially liquefiable material, the soil is granular and meets a specified range of grain sizes, and the soil is in a loose state of low relative density. If these conditions are present and strong ground motion occurs, portions of the soil column could liquefy, depending on the intensity and duration of the strong ground motion. Soils most susceptible to liquefaction are saturated, very loose to loose, fine grained sandy and silty soils. Any structures founded on or above potentially liquefiable soils may experience settling (both total and differential) and loss of foundation support during ground shaking. At present there are no known areas on Vandenberg AFB where liquefaction has occurred (U. S. Air Force 1987). The potential for liquefaction is considered low in the project area because soils are compacted and dense, and groundwater is not perched on clay zones; rather, it is locally confined by clay layers at the project site.

3bi.

The project will not violate water quality standards or waste discharge requirements. The project is exempt from preparation and implementation of a Construction Activities Storm Water Pollution Prevention Plan (SWPPP) because the total acreage disturbed during installation of the remedy (0.8 acre) is less than one acre. Waste discharge requirements will not be violated by the project since there will be no water discharged other than the use of potable water via a hose to irrigate the willow trees. Over-irrigation of the phytoremediation barrier will not occur. Groundwater will not be allowed to discharge on the ground surface during well development activities.

3bii.

The project will not have any affect on water supply wells or interfere with their groundwater recharge such that there would be a net deficit in aquifer volume. The nearest water supply wells are located in Barka Slough, approximately 6.5 miles southeast of the site. Groundwater at the site is not extracted for use a drinking water source. The willows planted to implement the remedy will likely lower the groundwater table along the remediation barrier with the ultimate goal of improving water quality downgradient of the barrier. The discharge rate of downgradient springs downgradient of the barrier will likely be decreased significantly. However, the project will not adversely affect existing land uses or planned uses for which permits have been granted since water is supplied to cattle that graze in the area via the base potable water system.

3biii.

There are no drainage channels where the phytoremediation barrier will be installed. Therefore, the phytoremediation project will not alter the existing drainage pattern of the area. The rate or amount of surface runoff will not be increased since the willow trees will not be over-irrigated. Thus, the project will not result in flooding on or off-site.

3biv.

The proposed phytoremediation project is designed to improve rather than degrade water quality by removing chlorinated solvents in groundwater. If successfully implemented, the contaminated groundwater will not discharge at the natural springs.

3c

The Table in Attachment I of this document lists species present or potentially present in the annual grassland scrub habitat at Site 32 Cluster (U.S. Air Force 2004). A Form 35 Permit (dig permit) will be required before construction or drilling commences. The Form 35 permit application is reviewed by 30 CES/CEV Environmental Flight who will determine the need for biological monitoring. The project will not be detrimental to animal life. Short-term land disturbance would occur at the site during well drilling and during willow tree installation that may temporarily affect localized habitat use. The willow trees will be fenced; thus reducing the localized habitat for use by some of the larger receptors (e.g., deer, coyote, and cattle). However, the fenced area is relatively small (0.8 acres) and would therefore not have a significant impact on habitat size. Equipment operation and travel will be limited to only what is necessary to complete the IRA to minimize impacts to on-site vegetation. If vegetation areas are significantly disturbed, they will be restored as necessary once the remedy is complete.

3d

A Form 35 Permit will be required before construction commences. The Form 35 permit application is reviewed by 30 CES/CEV Environmental Flight. The Vandenberg AFB Environmental Flight checks the project area for potential and known cultural resources before approving the construction. One cultural resource that has been identified near the project area is a designated area of archeological concern (Coleman 2004). Therefore, an archaeological monitor will be present, as required, during field activities to ensure that items of interest such as bones, fossils, or human artifacts of potential historical significance (if encountered) are protected. Fieldwork will resume only after all necessary protective actions are taken.

3e.

Minimal short-term transportation impacts would result from the project. Up to two months would be required to plant 360 Arroyo Willows and install 20 monitoring wells and 20 injection wells. The soil generated from drilling 20 monitoring wells and 20 injection wells will be placed in two roll-off bins, and removed from the site for disposal at an appropriate landfill. Licensed waste haulers will transport the soil and all California Department of Transportation requirements will be adhered to. Traffic control measures are not considered necessary as the project area is a remote area of north Vandenberg AFB and access to the base is highly restricted.

One to two weeks would be required to inject vegetable oil substrate and perform baseline environmental sampling. After the baseline sampling, periodic plant maintenance and groundwater monitoring would be performed by two personnel in one vehicle and in accordance with the project-approved work plan.

There would be no effects on public services and no police protection would be required Possible fire hazards, such as vehicle sparks igniting vegetation will be mitigated by requiring contractors to park in designated areas and by equipping the team with fire extinguishers, shovels, and telecommunications to contact the appropriate emergency personnel No effects on energy requirements (such as substantial increase in demand upon existing sources of energy or a requirement of the development of new sources of energy) would result from the project No effects on utilities would occur from the proposed project. Prior to starting work, a Form 35 Permit would be obtained. This permit requires the notification and approval of the base Utilities shops and 30th Communications Squadron Upon notification, these divisions will flag the location of utilities such as telephone, fiber-optic, and electric lines in the project area

DTSC Comment 4:

Section 4.1 Conceptual Site Model: VOCs in soil and groundwater are not shown on Conceptual Site Model (CSM) Figure 4.1-1. Also, please provide a figure showing the CSM for current and future human and ecological receptors exposure pathways. In addition, please provide the cumulative risk from soil and groundwater at the Site 32 cluster.

Air Force Response:

Comment noted. All conceptual site model figures produced by the Air Force do not have contaminant concentrations shown on them. Contaminant concentrations are shown on Section 3 figures in the RAW. As suggested, two figures will be added to the RAW showing current and future human receptor pathways and current and future ecological receptor exposure pathways. In addition, the cumulative risk from soil and groundwater will be extracted from the Draft Final RI Report and summarized in Section 4.1.

DTSC Comment 5:

Section 4.1.2 Groundwater Modeling Summary: Provide a copy of the modeling document prepared for Site 32 or reference the document if previously submitted to regulatory agencies.

Since the predicted maximum concentration for TCE at the seeps would reach 813 μg/L within 0 and 3 years, Site 35 would require an expedited response action and an aggressive cleanup strategy than the proposed treatability study. Also, the site may qualify for a time-critical removal action.

Air Force Response:

The groundwater modeling summary was prepared in the Draft Final Remedial Investigation Report submitted in June 2004. This document will be referenced in Section 4.1.2 of the RAW

The groundwater modeling results are highly dependent upon data collected from well 35-MW-8, where it is assumed in the model that a continuous line of high TCE groundwater is present, all of which discharges at the seep. The model predicts higher TCE concentrations in the area upgradient of 35-MW-8, where the proposed injection well array is currently envisioned. It should be noted that the first phase of work, the proposed groundwater investigation (Section 6.2), will generate additional groundwater data, which will serve to verify the model predictions. The proposed placement of the injection well array will be made following receipt and review of these additional groundwater data. The final location may be positioned closer to the "seep", if conditions dictate.

Also, it should be emphasized that the Site 35 "seep" is not considered a perennial water body, but an area where groundwater may *potentially* discharge to the surface. Under average precipitation years (as is true since 2000), the seep area near well 35-MW-8 is dry and no freshwater aquatic/emergent vegetation has been observed in this area. Under wet conditions as in 1998, groundwater discharge is evident only in terms of damp ground, sunken hoof prints, and/or minor surface water presence in surface depressions (see Section 2.2.6). The Site 35 "seep" is not considered an exposure location for aquatic receptors. Groundwater that may discharge at the seep was considered a potential drinking water source for terrestrial wildlife and cattle only and posed a negligible potential for current or future ecological impacts. With regards to human health impacts, there are potential health effects for hypothetical use of groundwater at Site 35. Therefore, from an exposure standpoint, the risk assessments do not indicate a need for a time-critical removal action.

DTSC Comment 6:

Section 4.2.2 Ecological Risk Evaluation:

a. Please assure that the RAW is consistent with revisions recommended by DTSC HERD in the September 13, 2004 memorandum from Michael Anderson (HERD) to Quang Than (OMF Cypress) addressing the Site 32C ecological risk assessment (in the Site 32C remedial investigation).

b. Plants short in stature may have roots that extend to groundwater (e.g. manzanita). Please state that groundwater at 5 feet is not accessible to most plants and wildlife.

c. Please also include plants as a receptor of concern for the Cattle Pond.

d. The conclusion that the Cattle Pond "exhibited no differences from reference conditions" is not correct. The Cattle Pond FETAX bioassay results showed that survival of frog embryos reared in Cattle Pond water was much greater than in the reference pond water (Turtle Pond).

e. Aquatic biota HQs greater than one for metals are suspect if the HQ analysis is based upon unfiltered surface water samples compared to ambient water quality criteria.

f. While the risk assessment suggests that current conditions do not pose a risk to frog embryo survival, future predicted concentrations of organic constituents in the Cattle Pond may be of concern. Please state this fact in the text.

g. Organic chemical concentrations in the Cattle Pond should be monitored to assure that levels of TCE/PCE and associated breakdown products are at 2001 or lower levels in surface water. Any increases in these chemicals from 2001 conditions (i.e., when the bioassay data were collected) should trigger some action, from pump and treat, to additional bioassays. The driver here would be red-legged frog, an endangered species

h. The last paragraph states that Site 35 groundwater that may discharge at the seep poses a negligible potential for current and future adverse ecological impacts. Was the risk calculated based on predicted TCE concentrations of 813 µg/L at the seep?

Air Force Response:

a. Comment noted. The ecological risk assessment summary in the RAW will be revised to be consistent with DTSC recommendations as necessary and appropriate.

b. Comment noted. The text will be revised by replacing "short-stature" to "most"

c. Emergent plants will be included as a receptor of concern for the Cattle Pond.

d. Comment noted. The text will be revised to indicate that the survival of frog embryos reared in Cattle Pond water was much greater than in the reference pond water (Turtle Pond).

e. The use of unfiltered surface water results was recommended by risk assessment guidance, but the Air Force agrees that filtered data provide a better perspective for ecological risk when compared against dissolved metal concentrations used in published toxicity studies It will be noted in the Draft Final Removal Action Work Plan that a comparison of ambient water quality criteria to filtered surface water data will be provided in the final RI report for Site 32 Cluster.

f. Future risks to aquatic biota at the freshwater spring and Cattle Pond from the Site 32 groundwater plume are unlikely. However, TCE in the Site 32 plume could pose a potential for adverse effects to amphibians in the future, based on comparisons to ranges of toxicity values Uncertainty concerning potential future risks to amphibians exists due to variability in limited toxicity data This information will be included in Section 4.2.2

g Organic compounds in the seep and Cattle Pond are being monitored regularly on a semiannual basis as part of the Basewide Groundwater Monitoring Program. Concentrations remain at levels measured in 2001. The purpose of the Site 32C RAW is to initiate an Interim Removal Action to address potential future contamination of these surface water bodies due to future migration of the upgradient Site 32 groundwater plume.

h. Current drinking risks to small-bodied terrestrial wildlife were based on combined data from surface water samples collected from the spring and Cattle Pond and the groundwater sample collected from monitoring well 35-MW-8, near the former seep. Current drinking risks to cattle were calculated from surface water data collected at the spring and Cattle Pond. Potential future exposures to groundwater were initially based on TCE at 813 μg/L, which is the current TCE concentration in groundwater at well 35-MW-8. A more pertinent predicted maximum exposure concentration of TCE at the spring and Cattle Pond is 12.5 μg/L, which is based on the Site 32 groundwater plume. Updated risk calculations based on the Site 32 TCE plume will be included in the final RI report.

DTSC Comment 7:

Section 4.3.1 Remediation Goals: Are there cleanup goals for vadose zone at Site 32 and 35?

Air Force Response:

For the purposes of the IRA at Site 32 and the Treatability Study at Site 35, no soil cleanup goals have been established. As previously noted in the Air Force response to comment 2b, site activities will focus solely on groundwater remediation (the phreatic zone), as no soil cleanup is recommended in the Draft Final RI submitted June 2004.

DTSC Comment 8:

Section 5.0 Evaluation of Remedial Alternatives:

a. The No Action/Monitored Natural Attenuation (MNA) alternative should be separated. Thus, No Action will be alternative 1 and MNA will be alternative 2

b. Add ICs as an alternative by itself and combined with MNA and all the remaining alternatives

c. Add Pump and Treat alternative for groundwater remedy

Air Force Response:

a At Site 32 Cluster, groundwater samples collected under the BGMP have historically been and are currently being analyzed for MNA parameters. For this reason, no action is considered to be functionally equivalent to MNA. There are currently no plans to eliminate groundwater monitoring at Site 32 Cluster. The Air Force therefore sees no advantage in separating out these two alternatives since they constitute the current status quo

b See response to comment for subpart a above. The Institutional Controls (IC) alternative entails no active remediation, and imposes administrative controls and/or land use restrictions to manage risk and exposures Since the IC alternative is managed and ultimately controlled via the Form 35 Permit process at Vandenberg AFB, any alternative screened would naturally entail some form of ICs. Separating itself out as a stand alone alternative does not appear to present any advantage to this document, but risks creating a more cumbersome document for public review.

The Air Force proposes to incorporate additional text to each of the three existing alternatives screened that addresses how ICs would be an integral component of each alternative. The additional text will include the need to prepare Five-Year Review Reports, so long as existing COC concentrations exceed levels appropriate for unrestricted use.

c The groundwater pump and treat scenario (as well as several other candidate scenarios) was initially evaluated and ultimately discarded in a preliminary screening exercise. Given the naturally slow relative groundwater flow rates, and the customarily high costs associated with P&T, it ranked very low on time effectiveness, cost, and implementability (due to the treatment plant construction issues) and was ultimately discarded from further consideration.

DTSC Comment 9:

Section 5.2.1 Alternative 1 No Action/MNA: Please discuss the time frame to achieve cleanup goals for the entire site not just the seep. Also, the fate and transport Figure 4.1-3 referenced in the document is missing.

Air Force Response:

Comment noted. The IRA is specific to the Site 32 groundwater plume; thus the time frame to achieve cleanup is discussed solely in terms of the Site 32 plume. The seep location is at the downgradient edge of Site 32 and is also considered an appropriate exposure location. Therefore, the time frame for exceeding cleanup goals was presented in terms of the seep. For the No Action/MNA alternative, the Site 32 plume currently exceeds cleanup goals and Site 32 groundwater is predicted to reduce to levels below the cleanup goals in 2027, when the plume leaves the site. The time frame to achieve cleanup goals is not discussed for the Site 35 plume. The Treatability Study is being designed to test the effectiveness of *in situ* bioremediation using an emulsified soybean oil substrate and the alternative analysis is not meant to address the Site 35 plume. Based on the modeling presented in the Draft Final RI, the Site 35 plume will exceed cleanup goals for greater than 200 years. This statement will be added to Section 4.1.2.

The reference to Figure 4.1-3 will be deleted from the text in Section 5.2.1

DTSC Comment 10:

Section 5.2.1.1 Overall Protection of Human Health and the Environment: Resolution 68-16 establishes the policy that high quality waters of the State shall be maintained to the maximum extent possible not the minimum extent possible.

Air Force Response:

The text cited from Section 5.2.1.1 will be revised as noted above.

DTSC Comment 11:

Section 5.2.2.6 & 5.2.3.6 Short-Term Effectiveness: Provide a detailed analysis of the short-term impacts on ecological receptors and mitigation measures to reduce the impacts

Air Force Response:

Sections 5.2.2.6 and 5.2.3.6 will be modified, as appropriate for each section, to include the following text. The habitat in the proposed IRA area of Site 32 is annual grassland which has historically been subjected to overgrazing. It currently features ruderal species and provides marginal habitat. The proposed IRA area is confined to a space of approximately 0.8 acres or less, which is small area relative to the site cluster. No federally threatened species are known to have been observed in the proposed IRA area. Therefore, short-term impacts to this area would be marginal as well, confined to a relatively small area. The phytoremediation alternative includes construction of a perimeter fence to protect trees from grazing cattle. The fence construction will permit small animals to enter the planted area, while restricting entrance from cattle and deer. The permeable reactive barrier (trench) will be a linear feature confined to a small area, and will result in short-term subsurface disturbance to a small area.

Mitigation measures would include using existing roads for ingress/egress and for temporary staging and stockpiling of equipment and any residual soil piles generated during the work. Depressions will be constructed around the bases of planted trees and watering will be scheduled to result in no surface water runoff. Periodic weed abatement would be conducted to foster tree growth.

DTSC Comment 12:

Section 5.2.3.2 Compliance with State and Federal requirements for Alternative 3 Phytoremediation Barrier: The barrier will be installed downgradient of the plume and may not achieve cleanup goals for the entire site.

Air Force Response:

The phytoremediation system is designed to intercept the plume so that it does not reach the exposure point defined as the seep. The lack of an exposure point at Site 32 dramatically lowers the overall risk of the Site 32 spring. In addition, the IRA is designed as a passive remediation system, dependent upon transport of the plume downgradient through the root system. Thus, as time passes, the root system will become more effective at intercepting and evapotranspiring the plume as it moves past the barrier. It is expected that over time the plume will completely pass through the root system, at which time, it will undergo remediation. The phytoremediation barrier is designed to potentially be viable as the final remedy for the downgradient portion of the Site 32 groundwater plume. However, further evaluation will be completed in the FS, as appropriate.

DTSC Comment 13:

Section 5.4 Summary of Preferred Remedial Alternative: According to the document, it will take 1 to 2 years for the willow trees roots to grow within the water table. Also, groundwater monitoring will be conducted quarterly for 1 year for purposes of the IRA. What are the performance standards for the preferred alternative and how closure of the site will be achieved?

Air Force Response:

The groundwater monitoring for the site will be continued through the Basewide Groundwater Monitoring Program (BGMP) after the one year of monitoring associated with the IRA. In terms of goals for the IRA, closure of the site may not be achievable with the IRA. The objective of the IRA is to lower the overall risk of the site by eliminating the exposure point at the seep; it is not intended to close the site, although it may prove viable as a final remedy of the Site 32 groundwater plume. The closure process of Site 32 will follow the standard closure pathway through a remedial action plan, remedial action construction, and long term operation and maintenance of the final remedy. Performance standards of the phytoremediation system will be more clearly defined within Section 5.4 of the document. The performance standards of the IRA include demonstrating a localized depression in the water table surface in the immediate vicinity of the barrier; documenting reductions in flow of the spring; and declines in COC concentrations downgradient from the barrier and in the spring over time.

DTSC Comment 14:

Section 6.0 Removal Action Implementation: The scope of work in Table 6.0-1 is not distinguishable for each phase of the implementation. Please re-format the table to provide adequate space between the different phases of the removal action.

Air Force Response:

Table 6.0-1 will be reformatted to more clearly distinguish the different phases of work specified in the RAW.

DTSC Comment 15:

Section 6 1.4 Site 32 and 35 Monitoring and Reporting: See comment # 13 above regarding the duration of groundwater monitoring

Air Force Response:

The monitoring and reporting for the IRA will continue through the Basewide Groundwater Monitoring Program (BGMP) on a semiannual basis. The progress of the phytoremediation barrier will be documented in the BGMP reports. This time period will allow a longer time range to evaluate the effectiveness of the barrier. These statements will be included in the Draft Final RAW.

DTSC Comment 16:

Section 8.3 Site 35 Treatability Study: Need Level IV validation for at least 10% of the samples.

Air Force Response:

Comment noted. The Air Force understands Level IV validation as tantamount to Contract Lab Program (CLP) level validation. This level of validation is generally specified for the highest level of data quality and is consistent with sample results that may be used in risk management decisions. Level IV validation is not currently and has not historically been specified for IRP work at Vandenberg AFB. Rather, a modified Level II validation, per the AFCEE QAPP, version 3 1, has been completed by Tetra Tech on 100% of IRP samples in cases where the results may be used for risk management decisions. This level of data validation has been performed under the oversight of DTSC and has consistently met with DTSC approval over the past several years. In addition, with the exception of EPA method 8260B for VOCs, the soil physical testing and the MNA parameter analytical tests are not rigorous enough to merit a Level IV test, and it is actually not clear how a Level IV validation could be performed on test results where the reports lack the necessary detail to satisfy a Level IV validation.

Since risks have already been calculated for Site 32 Cluster, Tetra Tech believes that only a portion of the samples undergoing rigorous testing protocols (i e VOCs via 8260B) require validation at the modified Level II. Therefore, Tetra Tech recommends modified Level II validation for a minimum of 10% of the samples submitted for rigorous analytical protocols (i.e EPA method 8260B).

The text will be changed in Section 8.3 to state "Data validation will be performed by Tetra Tech on a minimum of 10% of the samples analyzed for VOCs via EPA method 8260B, using a modified Level II in accordance with the Basewide SAP (U.S. Air Force, 2003)."

DTSC Comment 17:

Section 9.0 Public Involvement: Include DTSC Cypress office to the information repositories listed in Sections 9.1 1 and 9.2.

Air Force Response:

The DTSC Cypress office will be included in the information repository lists in Sections 9.1.1 and 9.2

DTSC Comment 18:

Table 8 0-1 Sites 32 and 35 Sampling Summary: Test Method for VOCs is SW8260B. Please correct the table

Air Force Response:

Table 8.0-1 will be revised to include the correction referenced above.

DTSC Comment 19:

Appendix B, Applicable or Relevant and Appropriate requirements: The appropriate citations from the California Code of Regulations (CCR) are not clearly identified or specified in the ARARs table. The **Attachment** to this letter contains the Chemical, Location, and Action-Specific ARARs DTSC has identified for the project. We also identified Advisories, Guidance, and Criteria to be Considered for the planned IRA at Site 32 Cluster. Please evaluate the ARARs and revise Appendix B accordingly.

Also, the comment under ARAR # 7 references site 13C. Please make appropriate corrections.

Air Force Response:

The proposed DTSC ARARs were evaluated and will be included in the Site 32 Cluster Draft Final RAW. Attachment 2 of this document is a draft version of the ARARs to be approved before they are included in the Draft Final. All DTSC ARARs, with the exception of those already addressed in Appendix B, were included in Attachment 2. In addition, ARAR #7 was revised as appropriate.

REFERENCES

Alterman, I , *et al*. (ed.)
1994 Seismotectonics of the Central California Coast Ranges, GSA Special Paper 292, Boulder CO

Coleman, D M.
2004 Memorandum regarding the review of cultural resources for IRP Remedial Action 32/35 by Dina M. Coleman, CEVPC, Cultural Resources. Notes from site Visits conducted 29 July 2004 and 2 August 2004. Memorandum dated 2 August.

International Conference of Building Officials
1997 Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada

U.S Air Force
1987 Mineral Resource Management Plan, Potential Exploration, Development, and Production of the Oil and Gas. Vandenberg AFB, California.

U S Air Force
2004 Draft Final Remedial Investigation Report, Site 32 Cluster – Site 32 (Missile Silo 576-D) and Site 35 (Missile Silo 576-G), Operable Unit 4 Remedial Investigation/Feasibility Study. Prepared for 30 CES/CEV Installation Restoration Program, Vandenberg Air Force Base, California and Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Prepared by Tetra Tech, Inc. June.

TABLES

Table 1
Regional Fault Characteristics

Fault Name and Section	Approximate Distance from Site (kilometers)	Seismic Source Type	Maximum Magnitude (Mmax)	Slip Rate (mm/yr)	Fault Type
LIONS HEAD	1 7	B	6 6	0 02	DS
CASMALIA (Orcutt Frontal Fault)	4 5	B	6 5	0 25	DS
HOSGRI	12 7	B	7.3	2 5	SS
SAN LUIS RANGE (S Margin)	21 6	B	7	0 2	DS
LOS ALAMOS-W BASELINE	23 4	B	6 8	0 7	DS
LOS OSOS	24 6	B	6 8	0.5	DS
SANTA YNEZ (West)	41 8	B	6 9	2	SS
RINCONADA	53 9	B	7.3	1	SS
SAN JUAN	65 5	B	7	1	SS
M RIDGE-ARROYO PARIDA-SANTA ANA	72 7	B	6 7	0 4	DS
SAN ANDREAS - 1857 Rupture	83 6	A	7 8	34	SS
SANTA ROSA ISLAND	88 2	B	6.9	1	DS
SANTA YNEZ (East)	92 7	B	7	2	SS
SANTA CRUZ ISLAND	94	B	6 8	1	DS
RED MOUNTAIN	94 4	B	6 8	2	DS
VENTURA - PITAS POINT	107.1	B	6.8	1	DS

Notes: - The data presented in this table are from the data file "CDMGUBCR" from the UBCSEIS computer program (Blake 1998). The data file is based on information from *Maps of Known Active Fault Near-Source Zones in California and Adjacent Parts of Nevada to be Used with the 1997 Uniform Building Code* (ICBO 1998)

A - Faults with a MwMax ≥ 7 and a slip rate ≥ 5 mm/yr

B - Faults with a MwMax ≥ 7 and a slip rate < 5 mm/yr MwMax < 7 and a slip rate > 2, or MwMax ≥ 6.5 and a slip rate < 2mm/yr

DS - dip slip fault

ICBO - International Conference of Building Officials

mm/yr - millimeters per year

Mmax - Fault segment earthquake maximum magnitude as defined in *Maps of Known Active Fault Near-Source Zones in California and Adjacent Parts of Nevada to be Used with the 1997 Uniform Building Code* (ICBO 1998)

MwMax - Maximum earthquake moment magnitued (Mw) where Mw is equal to the rigidity of the earth times the average amount of slip on the fault times the amount of fault area that slipped (http://earthquake usgs gov/recenteqsww/glossary htm)

SS - strike slip fault

Table 2
Historic Earthquake Catalogue Data Summary

Earthquake Location Latitude North	Longitude West	Earthquake Date	Earthquake Magnitude (M_L)	Estimated Site PGA (g)	Modified Mercalli Intensity (MM)	Approximate Distance From Site mi (km)
34.833	120.583	10/16/1936	4	0 146	VIII	1 3(2 1)
34.857	120.47	6/21/1966	4 1	0.098	VII	5.7(9 2)
34 883	120.683	2/1/1962	4 5	0.098	VII	7 9(12 8)
34 8	120 4	12/12/1902	5 7	0 166	VIII	9 3(15 0)
34 9	120 7	11/4/1927	7 5	0 427	X	9 4(15 1)
34.9	120.4	3/29/1928	5.3	0 123	VII	10 6(17.0)
34 868	120 376	9/23/1982	4	0 061	VI	11 0(17 7)
34 717	120.417	11/30/1944	4.1	0 063	VI	11 1(17 8)
34.667	120 5	6/13/1944	4	0.059	VI	11 4(18 4)
34.667	120 5	6/13/1944	4 4	0.073	VII	11.4(18 4)
34 667	120.5	6/13/1944	4.6	0 081	VII	11.4(18 4)
34.849	120.774	2/16/1937	4	0.056	VI	12 1(19 5)
35	120 5	7/26/1917	4	0.055	VI	12 6(20 3)
35	120 5	11/19/1927	5	0 093	VII	12 6(20 3)
34 918	120 8	6/20/1984	4.2	0 054	VI	14 9(24.0)
34 8	120 3	9/11/1902	4	0.048	VI	15.0(24 1)
34.8	120.3	9/11/1902	4	0.048	VI	15.0(24 1)
34 931	120.819	5/29/1980	4 7	0.066	VI	16 3(26 2)
34 7	120 3	7/31/1902	5 5	0 096	VII	17 2(27 6)
34 7	120 3	1/12/1915	5 5	0.096	VII	17 2(27 6)
34 6	120 7	12/5/1927	4.3	0.051	VI	17 3(27 9)
34 6	120 7	12/31/1927	4	0 043	VI	17 3(27 9)
34.6	120 4	7/28/1902	6 3	0 142	VIII	18.0(29 0)
34.6	120.4	8/1/1902	6 3	0 142	VIII	18.0(29 0)
34.583	120 333	12/17/1934	4.5	0 049	VI	21 1(34 0)
34.583	120.333	12/18/1934	4	0.037	V	21 1(34 0)
34 5	120 5	8/26/1949	4 2	0.039	V	22 7(36.5)
34.5	120.5	8/27/1949	4.9	0.057	VI	22.7(36 5)
34 55	120 783	9/29/1938	4	0 035	V	22 7(36 5)
34 55	120 783	3/19/1935	4	0 035	V	22 7(36 5)
34 55	120 783	6/16/1940	4	0 035	V	22 7(36 5)
34.55	120 783	10/17/1939	4	0.035	V	22 7(36 5)
34 737	120 148	10/25/1984	4.5	0.044	VI	24 2(39 0)
34 736	120 147	11/6/1986	4	0.034	V	24 3(39 1)
34 461	120 521	11/18/1936	4 5	0.043	VI	25 2(40 5)
34.456	120.521	10/1/1959	4.5	0 042	VI	25 5(41 1)
35.2	120.6	10/20/1913	4	0 032	V	26.0(41 9)
35.17	120.75	12/1/1916	5.7	0 078	VII	26 1(42.0)
34.5	120.8	12/24/1937	4	0 032	V	26 1(42 1)
34 445	120.467	9/9/1936	4	0.031	V	26 7(43.0)
34.7	120.1	7/28/1945	4 2	0.034	V	27 6(44 4)
35	121	3/27/1947	4 2	0.034	V	27 6(44 4)
35 25	120 5	7/9/1917	5 3	0.057	VI	29 6(47.6)
35 25	120 5	7/10/1917	5.3	0.057	VI	29.6(47 6)
35 25	120 5	7/9/1917	5	0 049	VI	29.6(47 6)
35 25	120.5	7/10/1917	5.3	0 057	VI	29 6(47 6)
35 25	120 67	9/5/1922	4	0.029	V	30 0(48 3)
35 25	120 67	12/17/1852	5.7	0.07	VI	30 0(48 3)
35 25	120 67	6/28/1920	4	0.029	V	30 0(48 3)
35 25	120.67	5/4/1923	4	0.029	V	30.0(48 3)
35 25	120.67	7/21/1931	4	0.029	V	30.0(48 3)
35 25	120 67	00/00/1830	5 7	0.07	VI	30.0(48 3)
35 25	120.67	12/15/1869	4 3	0.033	V	30 0(48 3)
34 37	120.623	11/22/1937	4.5	0 036	V	31 6(50 8)
35.28	120.48	5/21/1940	4	0 027	V	31 8(51 2)
35.3	120.7	12/7/1906	5 9	0.071	VI	33 8(54 3)
34 661	119 973	5/7/1984	4.2	0 028	V	35 3(56.8)
34 365	120 888	6/12/1969	4	0 024	V	36 7(59 1)
34 232	120.662	11/1/1936	4	0 022	IV	41 3(66.4)
34 291	120 938	1/9/1989	4 1	0.023	IV	42 6(68 5)
34.855	121.319	10/23/1969	4 1	0.023	IV	42 9(69 1)
35.47	120.75	2/3/1953	4.1	0.022	IV	45 8(73 7)
35 5	120 6	01/01/1830	5	0.034	V	46 7(75 2)
35.5	120.5	6/4/1953	4.3	0.024	IV	46.8(75 3)
34 707	121 377	12/3/1969	4	0 02	IV	46 9(75 5)
34 649	121.389	11/10/1969	4	0 02	IV	48 4(78.0)
34 653	121 41	11/9/1969	4 1	0.02	IV	49 5(79 7)
34.744	121.446	11/5/1969	4 5	0.025	V	50.4(81 1)
34.42	119 82	00/00/1862	5 7	0.047	VI	50.6(81 4)
35.5	120.92	11/27/1946	4 3	0.022	IV	50 8(81 8)
34 609	121 435	11/5/1969	5.6	0 044	VI	51 7(83 2)
34 471	119 757	11/16/1958	4	0.019	IV	51 8(83.4)
34.402	119.802	3/10/1986	4 1	0.02	IV	52 1(83 9)
34.4	119.8	9/9/1929	4.6	0.026	V	52 3(84 1)
34.5	121.4	4/3/1944	4	0.019	IV	52.6(84 6)
34 333	119 833	6/26/1933	4 3	0.021	IV	53 6(86 2)
34.333	119.833	6/26/1933	4.3	0.021	IV	53 6(86 2)
35.4	121 2	1/2/1960	4	0.018	IV	53 6(86 3)
34.5	119.7	8/26/1919	4	0.018	IV	53.8(86.6)

Table 2
Historic Earthquake Catalogue Data Summary

Earthquake Location		Earthquake	Earthquake	Estimated Site	Modified	Approximate
Latitude North	Longitude West	Date	Magnitude (M_L)	PGA (g)	Mercalli Intensity (MM)	Distance From Site mi (km)
34 5	119 7	7/29/1925	4	0 018	IV	53 8(86 6)
34 5	119.7	8/26/1919	4	0 018	IV	53 8(86 6)
35.3	119.8	01/09/1857	7.9	0 142	VIII	54 2(87 2)
34.754	121 515	10/28/1969	4	0 018	IV	54 2(87 3)
34.49	119.691	9/16/1962	4	0 018	IV	54 6(87 9)
35 6	120.8	6/29/1942	4	0.018	IV	55 2(88 8)
34 5	119 67	05/31/1854	4.3	0.021	IV	55 4(89 1)
34 5	119 67	06/01/1893	5	0.03	V	55 4(89 1)
34 5	119 67	03/14/1857	4 3	0 021	IV	55.4(89 1)
34 5	119.67	2/9/1902	4 3	0 021	IV	55 4(89 1)
34 5	119 67	06/25/1855	4 3	0 021	IV	55 4(89 1)
34.5	119.67	07/09/1885	4.3	0.021	IV	55 4(89 1)
34.35	119.767	11/10/1940	4	0 018	IV	55 8(89 8)
34 3	119 8	7/3/1925	5 3	0 035	V	56.5(90 9)
34 3	119 8	7/3/1925	5.3	0 035	V	56 5(90 9)
34 3	119 8	6/29/1925	6 25	0 057	VI	56 5(90 9)
34 4	119 7	6/24/1926	4	0 017	IV	57 1(91 9)
34.4	119 7	03/25/1806	5	0.029	V	57 1(91 9)
34 4	119 7	7/6/1926	4	0 017	IV	57 1(91 9)
34 4	119 7	8/9/1926	4	0 017	IV	57 1(91 9)
34.4	119.7	8/26/1927	4	0 017	IV	57.1(91 9)
34.325	119.761	8/9/1956	4	0 017	IV	57 1(91 9)
34	120.4	3/29/1911	4.6	0 024	IV	57 7(92 8)
35.67	120.67	9/8/1915	4	0.017	IV	58 7(94 5)
34 589	121.565	10/22/1969	4	0.017	IV	59 2(95 2)
34 347	119 696	8/13/1978	5.1	0.03	V	59 2(95 3)
34.598	121.586	10/24/1969	4	0 017	IV	60 2(96 8)
34 317	119.7	10/21/1953	4	0.017	IV	60 2(96 9)
33 955	120 71	12/3/1937	4	0 017	IV	60 6(97 5)
34.6	121 6	3/5/1962	4.5	0.022	IV	60 9(98.0)
34.6	121 6	3/10/1962	4	0.017	IV	60.9(98.0)
34.6	121.6	3/10/1962	4.2	0.018	IV	60 9(98.0)
34 2	119 8	12/21/1812	7	0.08	VII	61 1(98 4)
35.6	121.1	02/01/1853	5	0.028	V	61.5(99.1)

Summary

Earthquake Magnitude Range (M_L):
Minimum 4 00
Maximum 9 00

Site Coordinates:
Latitude: 34.8243
Longitude: 120 5622

Search Time Period: 1800 - 2000

Approx Search Radius in mi(km): 62 (100)

Nearest Earthquake Distance in mi(km): 1 3 (2 1)

Largest Earthquake Magnitude (M_L): 7 9

Largest Estimated Site Acceleration (g) 0 427

Earthquake Magnitudes and Exceedances

Earthquake Magnitude (M_L)	Number of Times Exceeded	Cumulative No./Year	Cumulative Recurrence Interval (years)
4	113	0 56219	1 78
4.5	41	0.20398	4 90
5	28	0.1393	7.18
5.5	15	0 07463	13 40
6	6	0 02985	33 50
6.5	3	0 01493	66 98
7	3	0 01493	66.98
7.5	2	0.00995	100.50

Notes:

- The data presented in this table are from the data file 'ALLQUAKE' from the EQSEARCH computer program (Blake 2000). The data file is based on information from the California Geologic Survey (CGS) computerized historic earthquake catalogue for the State of California compiled through 2000

g - Standard acceleration of gravity where g = 9 81 meters/second as estimated using a deterministic method
km - kilometer
mi - mile
MM - Modified Mercalli Scale. An earthquake intensity scale having twelve divisions ranging from I (not felt by people) to XII (damage nearly total).
M_L - Richter Scale A logarithmic scale of earthquake magnitude where the magnitude is the logarithm to base ten of the maximum seismic wave amplitude (in thousandths of a millimeter) measured on a standard seismograph 100
PGA - Peak Ground Acceleration using the probabilistic method in EQSEARCH (Blake 2000)

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ATTACHMENT 1

Attachment 1

Species Potentially Present in Annual Grassland Habitat, Site 32 Cluster, Vandenberg Air Force Base

SCIENTIFIC NAME	COMMON NAME	Regulatory Status	Recreational Status	Occurrence by Habitat (E = expected) (O = Observed)
AMPHIBIANS				
Ambystoma californiense	California tiger salamander	FT, CSC		**E**
Taricha torosa	California newt	CSC		**E**
Ensatina eschscholtzi croceator	Yellow-blotched salamander	CSC		**O**
Batrachoseps attenuatus	California slender salamander			**E**
Scaphiopus hammondi	Western spadefoot	CSC		**E**
Bufo boreas	Western toad			**E**
Hyla regilla	Pacific treefrog			**O**
Rana aurora draytonii	California red-legged frog	FT, CSC		**O**
Rana catesbeiana	Bullfrog		HA	**E**
REPTILES				
Sceloporus occidentalis	Western fence lizard			**O**
Uta stansburiana	Side-blotched lizard			**E**
Phrynosoma coronatum frontale	California coast horned lizard	CSC		**E**
Eumeces skiltonianus	Western skink			**O**
Cnemidophorus tigris	Western whiptail			**E**
Gerrhonotus multicarinatus	Southern alligator lizard			**O**
Anniella pulchra pulchra	Silvery legless lizard	CSC		**E**

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Species Potentially Present in Annual Grassland Habitat, Site 32 Cluster, Vandenberg Air Force Base

SCIENTIFIC NAME	COMMON NAME	Regulatory Status	Recreational Status	Occurrence by Habitat (E = expected) (O = Observed)
REPTILES				
Diadophis punctatus	Ringneck snake			E
Coluber constrictor	Racer			O
Masticophis flagellum	Coachwhip			E
Masticophis lateralis	California whipsnake			O
Pituophis melanoleucus	Gopher snake			E
Lampropeltis getulus	Common kingsnake			O
Thamnophis sirtalis ssp.	South coast garter snake			E
Thamnophis elegans	Western terrestrial garter snake			O
Tantilla planiceps	Western black-headed snake			E
Hypsiglena torquata	Night snake			E
Crotalus viridis	Western rattlesnake			O
BIRDS				
Anas platyrhynchos	Mallard		HA	E
Anas crecca	Green-winged teal		HA	E
Anas acuta	Northern pintail		HA	E
Anas discors	Blue-winged teal		HA	E
Anas cyanoptera	Cinnamon teal		HA	E
Anas strepera	Gadwall		HA	E
Anas americana	American wigeon		HA	E
Anas penelope	Eurasian wigeon			E
Fulica americana	American coot		HA	E
Larus delawarensis	Ring-billed gull			E
Larus californicus	California gull	CSC		E
Ardea herodias	Great blue heron			O

Species Potentially Present in Annual Grassland Habitat, Site 32 Cluster, Vandenberg Air Force Base

SCIENTIFIC NAME	COMMON NAME	Regulatory Status	Recreational Status	Occurrence by Habitat (E = expected) (O = Observed)
BIRDS				
Casmerodius albus	Great egret			E
Bubulcus ibis	Cattle egret			O
Cygnus columbianus	Tundra swan			E
Anser albifrons	Greater white-fronted goose		HA	E
Chen caerulescens	Snow goose		HA	E
Branta canadensis	Canada goose		HA	E
Pluvialis squatarola	Black-bellied plover			O
Pluvialis dominica	American golden-plover			E
Pluvialis fulva	Pacific golden-plover			O
Charadrius semipalmatus	Semipalmated plover			E
Charadrius alexandrinus nivosus	Western snowy plover	FT, CSC		E
Charadrius vociferus	Killdeer			O
Charadrius montanus	Mountain plover	CSC		O
Niumenius americanus	Long-billed curlew	CSC		E
Niumenius phaeopus	Whimbrel			E
Callipepla californica	California quail		HA	O
Elanus caeruleus	Black-shouldered kite			O
Haliaeetus leucocephalus	Bald eagle	FT (FPD), SE		O
Circus cyaneus	Northern harrier	CSC		O
Accipiter striatus	Sharp-shinned hawk	CSC		E
Accipiter cooperii	Cooper's hawk	CSC		O
Buteo jamaicensis	Red-tailed hawk			O
Buteo lineatus	Red-shouldered hawk			O
Buteo regalis	Ferruginous hawk	CSC		O
Buteo lagopus	Rough-legged hawk			E
Aquiala chrysaetos	Golden eagle	CSC		O
Cathartes aura	Turkey vulture			O

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Species Potentially Present in Annual Grassland Habitat, Site 32 Cluster, Vandenberg Air Force Base

SCIENTIFIC NAME	COMMON NAME	Regulatory Status	Recreational Status	Occurrence by Habitat (E = expected) (O = Observed)
BIRDS				
Falco sparverius	American kestrel			O
Falco columbarius	Merlin	CSC		E
Falco peregrinus anatum	Peregrine falcon	SE		E
Falco mexicanus	Prairie falcon	CSC		E
Tyto alba	Barn owl			O
Otus kennicottii	Western screech owl			E
Bubo virginianus	Great horned owl			O
Athene cunicularia hypugea	Burrowing owl	CSC		O
Asio otus	Long-eared owl	CSC		E
Asio flammeus	Short-eared owl	CSC		E
Chordeiles acutipennis	Lesser nighthawk			E
Phaelaenoptilus nuttallii	Common poorwill			E
Aeronautes saxatalis	White-throated swift			E
Zenaida macroura	Mourning dove		HA	O
Columba livia	Rock dove			O
Geococcyx californianus	Greater roadrunner			O
Colaptes auratus	Northern flicker			O
Sayornis saya	Say's phoebe			O
Tyrannus vociferans	Cassin's kingbird			E
Tyrannus verticalis	Western kingbird			O
Eremophila alpestris actia	California horned lark	CSC		O
Anthus rubescens	American pipit			O
Progne subis	Purple martin	CSC		E
Tachycineta bicolor	Tree swallow			O
Tachycineta thalassina	Violet-green swallow			E
Stelgidopteryx serripennis	Northern rough-winged swallow			E
Hirundo pyrrhonota	Cliff swallow			E

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Species Potentially Present in Annual Grassland Habitat, Site 32 Cluster, Vandenberg Air Force Base

SCIENTIFIC NAME	COMMON NAME	Regulatory Status	Recreational Status	Occurrence by Habitat (E = expected) (O = Observed)
BIRDS				
Hirundo rustica	Barn swallow			E
Corvus brachyrhynchos	American crow		HA	O
Pica nuttalli	Yellow-billed magpie			O
Thryomanes bewickii	Bewick's wren			O
Mimus polyglottos	Northern mockingbird			O
Turdus migratorius	American robin			E
Sialia currucoides	Mountain bluebird			E
Sialia mexicana	Western bluebird			O
Sturnus vulgaris	European starling			O
Vireo gilvus	Warbling vireo			O
Dendroicia coronata	Yellow-rumped warbler			E
Guiraca caerulea	Blue grosbeak			E
Passerine amoena	Lazuli bunting			E
Euphagus cyanocephalus	Brewer's blackbird			O
Agelaius tricolor	Tricolored blackbird	CSC		E
Agelaius phoeniceus	Red-winged blackbird			O
Sturnella neglecta	Western meadowlark			O
Molothrus ater	Brown-headed cowbird			O
Zonotrichia leucophrys	White-crowned sparrow			O
Zonotrichia atricapilla	Golden-crowned sparrow			E
Chondestes grammacus	Lark sparrow			O
Aimophila ruficeps canescens	Southern California rufous-crowned sparrow	CSC		O
Spizella passerina	Chipping sparrow			E
Pooecetes gramineus	Vesper sparrow			E
Melospiza melodia	Song sparrow			E
Melospiza lincolnii	Lincoln's sparrow			E

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Species Potentially Present in Annual Grassland Habitat, Site 32 Cluster, Vandenberg Air Force Base

SCIENTIFIC NAME	COMMON NAME	Regulatory Status	Recreational Status	Occurrence by Habitat (E = expected) (O = Observed)
BIRDS				
Passerculus sandwichensis	Savannah sparrow			E
Ammodramus savannarum	Grasshopper sparrow			O
Pipilo crissalis	California towhee			O
Dolichonyx oryzivorus	Bobolink			E
Carpodacus mexicanus	House finch			O
Carduelis tristis	American goldfinch			E
Carduelis lawrencei	Lawrence's goldfinch			E
Carduelis psaltria	Lesser goldfinch			O
Pheucticus melanocephalus	Black-headed grosbeak			O
MAMMALS				
Didelphis virginiana	Virginia opossum		HA	O
Sorex trowbridgii	Trowbridge shrew			O
Sorex ornatus	Ornate shrew			O
Scapanus latimanus	Broad-footed mole			E
Myotis yumanensis	Yuma myotis			E
Myotis thysanodes	Fringed myotis			E
Myotis volans	Long-legged myotis			E
Myotis californicus	California myotis			E
Myotis leibii	Small-footed myotis			E
Lasionycteris noctivagans	Silver-haired bat			E
Pipistrellus hesperus	Western pipistrelle			E
Eptesicus fuscus	Big brown bat			E
Lasiurus borealis	Red bat			E
Lasiurus cinereus	Hoary bat			E
Plecotus townsendii townsendii	Townsend's western big-eared bat	CSC		E
Antrozous pallidus	Pallid bat	CSC		E

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Species Potentially Present in Annual Grassland Habitat, Site 32 Cluster, Vandenberg Air Force Base

SCIENTIFIC NAME	COMMON NAME	Regulatory Status	Recreational Status	Occurrence by Habitat (E = expected) (O = Observed)
MAMMALS				
Tadarida brasiliensis	Brazilian free-tailed bat			E
Eumops perotis californicus	California mastiff bat	CSC		E
Lepus californicus	Black-tailed jackrabbit		HA	O
Sylvilagus audubonii	Desert cottontail		HA	O
Sylvilagus bachmanii	Brush rabbit		HA	E
Tamias merriamii	Merriam's chipmunk			E
Spermophilus beecheyi	California ground squirrel			O
Thomomys bottae	Valley pocket gopher			O
Perognathus californicus	California pocket mouse			O
Dipodomys heermanni	Heermann's kangaroo rat			E
Dipodomys agilis	Pacific kangaroo rat			O
Reithrodontomys megalotis	Western harvest mouse			O
Peromyscus maniculatus	Deer mouse			O
Peromyscus boylii	Brush mouse			E
Peromyscus truei	Piñon mouse			E
Onychomys torridus	Southern grasshopper mouse			E
Microtus californicus	California vole			O
Mus musculus	House mouse			E
Procyon lotor	Raccoon			E
Mustela frenata	Long-tailed weasel			E
Taxidea taxus	American badger			O
Spilogale gracilis	Western spotted skunk		HA	E
Mephitis mephitis	Striped skunk		HA	O
Canis latrans	Coyote			O
Urocyon cinereoargenteus	Gray fox			E
Ursus americanus	Black bear			E

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Species Potentially Present in Annual Grassland Habitat, Site 32 Cluster, Vandenberg Air Force Base

SCIENTIFIC NAME	COMMON NAME	Regulatory Status	Recreational Status	Occurrence by Habitat (E = expected) (O = Observed)
MAMMALS				
Felis concolor	Mountain lion			E
Lynx rufus	Bobcat			E
Sus scrofa	Feral hog		HA	E
Odocoileus hemionus	Mule deer		HA	O

Notes:

Regulatory status:

FT: Federally listed as threatened

FPD: Federally proposed for delisting

SE: California listed as endangered

CSC: California Department of Fish and Game "Species of Special Concern"

Recreational status:

HA: Hunted animal

ATTACHMENT 2

Appendix B
ARARs for Site 32
Groundwater IRA

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Chemical-Specific ARARs					
Safe Drinking Water Act, 42 USC 300					
1	National Primary Drinking Water Standards	40 CFR, Part 141	Establishes maximum contaminant levels (MCLs) for public water systems	Relevant & Appropriate	The NCP defines MCLs as relevant and appropriate for groundwater determined to be a current or potential source of drinking water in cases where MCLGs are not ARARs. Groundwater in the vicinity of VAFB has been designated for potential drinking water use.
2	Maximum Contaminant Level Goals (MCLGs)	40 CFR, Part 141	Establishes potable water quality goals.	Relevant & Appropriate	MCLGs that have non-zero values are relevant and appropriate for groundwater to be a current or potential source of drinking water. Groundwater in the vicinity of VAFB has been designated for potential drinking water use.
Clean Water Act, 33 USC 1251 et seq.					
3	Water Quality Standards and Criteria	33 USC, 1313 and 57, Federal Register 60920-60921	Establishes the requirement of water quality standards for discharges to waters of the United States	Potentially Relevant & Appropriate	Applies to any potential site discharge to waters of the United States.
Hazardous Waste Control Act (HWCA)					
4	Concentration limits of regulated units effluent to groundwater, surface water, and soil	Title 22, CCR, Div 4.5, Ch 14, §66264.94	Groundwater and vadose zone protection standards: RCRA hazardous waste TSD facilities shall comply and ensure that hazardous constituents entering the groundwater, surface water, and soil from a regulated unit do not exceed the concentration limit from contaminants of concern in the uppermost aquifer underlying the waste management area beyond the point of compliance.	Potentially Relevant & Appropriate	Applicable for hazardous waste TSD facilities; potentially relevant and in site-specific circumstances, such as when the source of waste is unknown but the waste is similar in composition to listed waste or when waste constituents have released or have the potential to release to groundwater. This site is not a TSD facility, and existing concentrations of constituents present in site mdeia are generally below levels that would classify them as hazardous waste.
5	Hazardous waste listing and identification	Title 22, CCR, Div 4.5, Ch 11, §66261.2, §66261.3	Identification of hazardous waste that poses a potential hazard to human health or the environment when it is improperly treated, stored, transported, or disposed.	Potentially Relevant & Appropriate	Hazardous waste determinations for soil cuttings generated from well installations and any extracted groundwater (e.g., purge water) will be made at the time that wastes are generated.
Resource Conservation and Recovery Act (RCRA)					
6	RCRA Hazardous Waste and toxic characteristics leaching procedure (TCLP) levels	Title 22, CCR	Defines RCRA hazardous waste and TCLP regulatory levels.	Potentially Relevant & Appropriate	Hazardous waste determinations for soil cuttings generated from well installations and any extracted groundwater (e.g., purge water) will be made at the time that wastes are generated.
Cal/EPA DTSC					
7	Non RCRA Hazardous Waste; persistent and bioaccumulative toxic substances, total threshold limit concentrations (TTLCs), and soluble threshold limit concentrations (STLCs).	Title 22, CCR, Div 4.5, Ch. 11	Defines non-RCRA hazardous waste, persistent and bioaccumulative toxic substances, and regulatory levels for TTLC and STLC analyses.	Applicable	Hazardous waste determinations for soil cuttings generated from well installations and any extracted groundwater (e.g., purge water) will be made the time that wastes are generated.
8	State maximum contaminant level (MCL) list	Title 22, CCR, Div 4, Ch. 15	The primary MCLs are drinking water quality standards established by the U.S. EPA under the Safe Drinking Water Act, the State of California under Domestic Water Quality and Monitoring Regulations. Primary MCLs present risk to the human health when used for drinking or culinary purposes.	Relevant & Appropriate	State MCLs are tap water standards that are relevant and appropriate for the potential drinking water aquifers at VAFB.
9	State Secondary MCL list	Title 22, CCR, Div 4, Ch15	Secondary MCLs may be objectionable to an appreciable number of people but are not generally hazardous to human health.	Potentially Relevant & Appropriate	None of the chemicals of concern for the Site 32C IRA have secondary MCLs.
State and Regional Water Quality Control Board (RWQCB)					
10	Porter Cologne Water Quality Control Act (California Water Code Sections 13240, 13241, 13242, 13243)	Water Quality Control Plan (Basin Plan) for the RWQCB, CCR Includes the State Water Resources Control Board's Water Quality Control Plan for Ocean Waters of California (Ocean Plan)	Establishes water quality objectives, including narrative and numerical standards, that protect the beneficial uses and water quality objectives of surface and ground waters in the region. Describes implementation plans and other control measures designed to ensure compliance with statewide plans and policies and provide comprehensive water quality planning.	Applicable	Specific applicable portions of the Basin Plan include beneficial uses of affected water bodies and water quality objectives to protect those uses. Any activity, including, but not limited to, the discharge of contaminated soils or waters or in-situ treatment or containment of contaminated soils or waters, must not result in actual water quality exceeding water quality objectives.
11	Porter Cologne Water Quality Control Act (California Water Code Sections 13000, 13140, 13240)	State Water Resources Control Board Resolution (SWRCB) 88-63 (Source of Drinking Water Policy)	Designates all ground and surface waters of the State as drinking water except where the TDS is greater than 3,000 ppm, the well yield is less than 200 gpd from a single well, the water is a geothermal resource or in a water conveyance facility, or the water cannot reasonably be treated for domestic purposes using either best management practices or best economically achievable treatment practices.	Applicable	Applies in determining beneficial uses for waters that may be affected by discharges of waste. The groundwater at VAFB has been identified as a source of drinking water.

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Chemical-Specific ARARs					
State and Regional Water Quality Control Board (RWQCB)					
12	Policy Regarding Maintenance of Water Quality in California	SWRCB Resolution 68-16 (Policy with Respect to Maintaining High Quality Waters in California)	Requires that quality of waters of the State is better than needed to protect all beneficial uses be maintained unless certain findings are made. Dishcare to high quality waters must be treated using best practicable treatment or controls necessary to prevent pollution or nuisance and to maintain the highest quality water. Requires cleanup to background water quality or to lowest concentrations technically and economically feasible to achieve Beneficial uses must, at least, be protected.	Applicable	Applicable for any surface discharge or subsurface injection of treated water.
13	Porter-Cologne Water Quality Control Act (California Water Code Sections 13000, 13140, 13240)	SWRCB Resolution No. 88-63 ("Sources of Drinking Water Policy") (as contained in the RWQCB's Water Quality Control Plan)	Specifies that, with certain exceptions, all ground and surface waters must have the beneficial use of municipal or domestic water supply.	Applicable	Applies in determining beneficial uses for waters that may be affected by discharges of waste.
14	Porter-Cologne Water Quality Control Act	Water Code, Div. 7, §13000 et seq.	Establishes authority of State and Regional Water Boards to protect water quality by regulating waste disposal and requiring cleanup of hazardous conditions that affect waters of the state. Defines designated waste; sets requirements for laboratories; sets report requirements for waste discharges and specifies well drilling requirements and reporting.	Applicable	Defines waste and sets requirements for investigations and analyses.
15	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20400, Title 23, CCR, §2550.4.	Concentration limits must be established for groundwater, surface water, and the unsaturated zone. Must be based on background, equal to background, or for corrective actions, may be greater than background, not to exceed the lower of the applicable water quality objective or the concentration technologically or economically achievable. Specific factors must be considered in setting cleanup standards above background levels.	Applicable	Applies in setting ground water cleanup levels for any discharges of waste to land.
16	California Safe Drinking Water Act (California Health & Safety Code Section 4010 et seq.)	Title 22, CCR, §64400 et seq.	Requirements for public water systems. Includes MCLs and Secondary MCLs.	Relevant & Appropriate	The act is legally applicable for an aquifer and associated distribution and pre-treatment system that is currently defined as "public water system" If it is only a potential "Public water system," then the act is relevant and appropriate.
17	Safe Drinking Water & Toxic Enforcement Act (aka Prop. 65)	Health and Safety Code, Division 20, Chapt. 6.6, §25249.5 et seq.	Prohibits discharges of specified carcinogens and reproductive toxins into current or potential drinking water sources.	Relevant & Appropriate	Prohibits discharges of specific substances to drinking water sources.

TO BE CONSIDERED STATE ADVISORIES, GUIDANCE, AND CRITERIA, CAL/EPA, DTSC

1 *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities*
DTSC Human and Ecological Risk Division

2 *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities*
DTSC Human and Ecological Risk Division

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Location-Specific ARARs					
18	National Archaeological and Historical Preservation Act	16 USC, 469a-1 and 36 CFR 65	Construction on previously undisturbed land would require an archaeological survey of the area	Applicable	Archaeological surveys have been conducted at VAFB: archaeological monitors should to be present to clear all drilling locations in order to protect cultural resources.
19	Endangered Species Act of 1973	16 USC, 1536(a)	Action to protect critical habitat upon which endangered species or threatened species depend must be taken.	Applicable	Sensitive habitat mitigation measures will be followed during implementation of this IRA.
20	Fish and Game Code	Fish and Game Code, §2080	No person shall import, export, take, possess, or sell any endangered or threatened species or part of product thereof.	Potentially Applicable	Endangered species are present at VAFB.
21	Within 200 feet of a fault displacement in Holocene time	Title 22, CCR, Div 4.5, Ch 14, §66264.18	New facility for treatment, storage, or disposal of hazardous waste prohibited.	Potentially Relevant & Appropriate	The location requirements are considered relevant and appropriate for the siting of remedial systems to reduce the toxicity, volume and/or mobility of chemicals. However, IRA treatment system is in-situ (i.e. trench installation or planting trees); not a conventional constructed system.
22	Within a 100-year floodplain	Title 22, CCR, Div 4.5, Ch 14, §66264.18	Facility must be designed, constructed, operated, and maintained to prevent washout by flood or maximum high tide.	Potentially Relevant & Appropriate	Same as above
23	Porter-Cologne Water Quality Control Act (California Water Code Section 13000 et seq.)	California Water Code, §13243	The RWQCB may specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted.	Applicable	Applies to groundwater remedial action.

TO BE CONSIDERED STATE ADVISORIES, GUIDANCE, AND CRITERIA, CAL/EPA, DTSC

1 *Drilling, Coring, Sampling and Logging at Hazardous Substance Release sites*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

2 *Reporting Hydrogeologic Characterization Data at Hazardous Substance Release sites*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

3 *Guidelines for Hydrogeologic Characterization of Hazardous Substance Release Sites, Volume 1 & 2*
Cal/EPA, July 1995

4 *Aquifer Testing for Hydrogeologic Characterization*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

5 *Application of Borehole Geophysics at Hazardous Substance Release Sites*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

6 *Ground Water Modeling for Hydrogeologic Characterization*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

7 *Monitoring Well Design and Construction for Hydrogeologic Characterization*
Guidance Manual for Ground Water Investigations
Cal/EPA, July 1995

8 *Advisory – Active Soil Gas Investigation*
DTSC/CRWQCB-Los Angeles Region, January 2003

9 *Representative Sampling of Ground Water for Hazardous Substances*
Cal/EPA, July 1995

10 *Accumulating Hazardous Waste at Generator Sites*
Cal/EPA, July 1995

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Action-Specific ARARs					
24	Offsite Management Requirements for CERCLA Wastes	58 CFR 49200-49218 40 CFR 300.440	Establishes requirements for managing CERCLA response action wastes at offsite Treatment, Storage and Disposal (TSD) facilities.	Applicable	Applicable for off-site treatment or disposal of removed materials (e.g., drill cuttings, construction materials, or purge waters).
25	National Pollutant Discharge Elimination System (NPDES)	40 CFR Parts 122-125	Requires permits for the discharge of pollutants from any point source into the waters of the United States.	Relevant & Appropriate	No discharge to grade planned for IRA; however, best management practices will be implemented to protect storm water discharges.
26	Hazardous Waste Control Act (HWCA)	Title 22, CCR, Div 4.5, §66262.10(a), §66262.11	Requires that the generator shall determine if a waste is hazardous waste.	Applicable	Applicable for any operation where waste is generated.
27	HWCA	Title 22, CCR, Div, 4.5, §66262.34	Generator may accumulate waste on site for 90 days or less or must comply with requirements for operating a storage facility	Applicable	No storage of hazardous waste is planned as part of this IRA. Accumulation of hazardous wastes on site for longer that 90 days would be subject to RCRA requirements for storage facilities.
28	HWCA	Title 22, CCR, Div 4.5, §66262.40, §66262.41	Generator must keep records of manifests, test results and waste analyses.	Applicable	Applicability of this requirement is contingent upon generation and management of hazardous waste.
29	HWCA	Title 22, CCR, Div 4.5, Ch 12, §66262.12	A generator shall not treat, store, dispose of, transport or offer for transportation, hazardous waste without having received an identification number.	Applicable	Applicable for any operation where waste is generated. The determination of whether wastes generated during remedial activities are hazardous shall be made when the wastes are generated.
30	HWCA	Title 22, CCR, Div 4.5, Ch 12, §66262.20, §66262.22	A generator of hazardous waste who transports or offers hazardous waste for transportation shall prepare a manifest.	Applicable	Same as above.
31	HWCA	Title 22, CCR, Div 4.5, Ch 12, §66262.30, §66262.31, §66262.32, and §66262.33	Before transporting hazardous waste or offering hazardous waste for transportation off-site, the generator must do the following in accordance with DOT regulations: package the waste, label and mark each package of hazardous waste, and ensure that the transport vehicle is correctly placarded.	Applicable	Same as above.
32	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 2	Establish requirements for a hazardous waste treatment facility to have a plan for waste analysis, develop a security system, conduct regular inspections, provide training to facility personnel, and use a quality assurance program during construction.	Potentially Relevant & Appropriate	Sites 32 and 35 are not a TSD facility. The determination of whether wastes generated during remedial activities are hazardous shall be made when the wastes are generated.
33	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 3, 4	Establish requirements for a facility to plan for emergency conditions. In addition, the design and operation of the facility must be done to prevent releases. Other requirements include testing and maintenance of equipment and incorporation of communication and alarm systems and contingency plan.	Potentially Relevant & Appropriate	Same as above.
34	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 9	The remedial activities may involve treatment within containers and/or storage of treatment residuals in containers. These containers must be in good condition, compatible with the waste, kept closed except to add or remove materials and be inspected weekly. The area used to store the containers must provide adequate secondary containment and be designed with runoff controls. Also, appropriate closure of the containers must take place.	Relevant & Appropriate	The requirements may be applicable if CERCLA response action constitutes treatment, storage, or disposal as defined under RCRA, or may be relevant and appropriate if the requirements address problems or situations sufficiently similar to the specific circumstances at the site that their usage will be well suited. Sites 32 and 35 are not a TSD facility, and treatment is in-situ (i.e. no tanks are specified to be used).
35	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 10	The remedial activities may involve storage and/or treatment in tanks. These tanks are required to have secondary containment, be monitored and inspected, be provided with overfill and spill protection controls, and operated with adequate freeboard. Also, appropriate closure must take place.	Relevant & Appropriate	Same as above.
36	HWCA	Title 22, CCR, Div 4.5, Ch 14, Article 12	The waste piles should be placed upon a lined foundation or base with a leachate system, protected from precipitation and wind dispersal, designed to prevent run on and run off. Also, closure and post-closure care requirements.	Relevant & Appropriate	Remedial action may involve soil excavation and the compiling of soil in a temporary waste pile for the injection barrier.

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Action-Specific ARARs					
37	HWCA	Title 22, CCR, Div 4.5, Ch 18, Article 1, 3, 4, 10, 11	Movement of hazardous waste to new locations and placed in or on land will trigger LDR. General applicability, dilution prohibited, waste analysis and record keeping, and special rules apply for wastes that exhibit a characteristic waste. Best Demonstrated Available Technology (BDA) standards for each hazardous constituents in each listed waste, if residual is to be disposed. Treatment standards table when necessary.	Applicable	Where applicable, hazardous waste generated from remedial activities must comply with LDR and meet or notify the disposal facility of the treatment standards before disposal at an appropriate offsite disposal facility.
38	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.111, §66264.112, §66264.115 through 120	Owners and operators shall close a facility and perform post-closure care when contaminated subsurface soil cannot be practically removed or decontaminated.	Relevant and Appropriate	Contaminated soil, residues, or groundwater from remedial action at a site will achieve clean closure, otherwise, post-closure care requirements will be relevant and appropriate.
39	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.91 (a) and (c)	Owners or operators of a RCRA surface impoundment, waste pile, land treatment unit, or landfill shall conduct a monitoring and response program for each regulated unit.	Relevant and Appropriate	Substantive technical requirements are potentially relevant and appropriate for remedial action including groundwater monitoring.
40	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.97 (b), (c), (d) and (e)(1) through (e)(5)	Requirements for monitoring groundwater, surface water, and vadose zone.	Relevant and Appropriate	Same as above
41	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.193 (b) and (c)	In order to prevent release of hazardous constituents to the environment, tank systems, including ancillary equipment, shall have secondary containment (e.g., double-wall piping).	Relevant and Appropriate	Potentially applicable to conventional remedial systems; however, only wells comprised the remedial alternatives considered in this IRA.
42	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.98	Requires the owner or operator of a regulated unit to develop a detection monitoring program that will provide reliable indication of a release.	Relevant and Appropriate	Same as above
43	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.99	Requires the owner or operator of a regulated unit to develop an evaluation monitoring program that can be used to assess the nature and extent of a release from the unit.	Relevant and Appropriate	Same as above
44	HWCA	Title 22, CCR, Div 4.5, Ch 14, §66264.100 (a) through (d), (f), (g)(1), and (h)	The owner or operator is required to take corrective action under Title 22, CCR, §66264.91 to remediate releases from the regulated unit and to ensure that the regulated unit achieves compliance with the water quality protection standard.	Relevant and Appropriate	Same as above
45	Safe Water Drinking Act (SFDA), Underground Injection Control (UIC) Regulations Toxic Injection Well Control Act of 1985	40 CFR, §260.10 Parts 144 through 147 Cal. Health and Safety Code, §25159.10 through 25	Establishes minimum requirements for UIC programs such as permits for the injection wells. Injection may not cause a violation of the primary MCLs and requires the evaluation of the quality of water.	Applicable	Potentially applicable for alternative utilizing a groundwater injection option to aquifers that are or may reasonable be expected to be a source of drinking water. If the treated water is most likely to be at or below the applicable primary MCLs, it is highly unlikely to be classified as either a RCRA or non-RCRA hazardous waste. Consequently, the reinjection wells would be Class V wells under SDWA UIC regulations. The substantive requirements of UIC regulations for Class V wells need to be met.
46	California Health and Safety Code California Civil Code	Cal. Health and Safety Code, §25202.5, 25222.1 Cal. Civil Code, §1471	Allows DTSC to enter into an agreement with the owner of a hazardous waste facility to restrict present and future land usages. Provides a streamlined process to be used for entering into an agreement to restrict specific usage of property in order to implement land-use restrictions	Relevant and Appropriate	The substantive provisions of Cal. Health and Safety Code (HSC), §25202.5 are the general narrative standards to restrict "[p]resent and future uses of all or part of the land on which the … facility … is located …" HSC §25222.1 provides the authority for the state to enter into voluntary agreement to establish land-use covenants with the owner of the property. The substantive provision of this section is the general narrative standard "[restricting specified uses of the property]". Cal. Civil Code §1471 provides conditions under which land-use restrictions will apply to successive owners of land.
47	Occupational Health and Safety Act	Cal. Health and Safety Code, Div 5, §6300 et seq.	Specific requirements that employers must meet to ensure the safety of the employees	Relevant and Appropriate	The provisions of this act should be followed for the removal action. A health and safety plan has been developed for the proposed removal action and is contained in the IRA Work Plan.

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Action-Specific ARARs					
48	CCR	Title 22, CCR, §66264	Container storage requirements and storage time limitations	Applicable	Applicability of this requirement is contingent upon generation and management of hazardous waste.
49	U.S. Department of Transportation	49 CFR, 171-172	Regulates storage, packaging, labeling, and placarding requirements for hazardous materials with regards to transportation.	Applicable	Portions of these requirements would be ARARs for transport of material on site. Off-site transport must comply with both substantive and administrative requirements.
50	State Hazardous Waste Regulations Discharges of Waste to Land	Title 23, CCR, §2510-§2600	Regulates waste discharges to land that may affect water quality. Includes siting, design, construction, operation, closure and monitoring standards and criteria for establishing cleanup levels.	Applicable	Substantive requirements of these regulations are applicable at Site 32C.
51	Hazardous Waste Control Act as implemented by Standards for Generators of Hazardous Waste	Health and Safety Code, Sec. 25100 et seq., Title 22, CCR, Div. 4.5, §66262	Establishes state hazardous program in lieu of federal RCRA. Establishes standards for generators and transporters of hazardous wastes in California. Authorization for state program was obtained from U.S. EPA in 1992. Establishes recordkeeping, reporting and manifesting standards for hazardous waste generators in California. Establishes storage accumulation time, requires hazardous waste determination, specifies labeling, container segregation of incompatible wastes, and secondary containment requirement.	Applicable	CERCLA sites are exempt from these administrative requirements. Substantive requirements will apply for any offsite transportation of wastes from Site 32C.
52	Hazardous Waste Control Act as implemented by Land Disposal Restrictions	Title 22, CCR, Div. 4.5, §66268	Identifies wastes and chemical concentration levels that are restricted from land disposal.	Applicable	Will be applicable for drill cuttings or treatment residuals with chemical concentrations exceeding regulatory levels.
53	Hazardous Waste Control Act as implemented by Corrective Action Management Units (CAMU)	Title 22, CCR, Div. 4.5, §66264.552	Establishes location and operating requirements for Corrective Action Management Units used in remedial actions.	Applicable	Applicable for treatment units for excavated soil (e.g., drill cuttings), landfilled material, or extracted water. Applies to both RCRA and non-RCRA wastes.
54	Hazardous Waste Control Act as implemented by Temporary Units	Title 22, CCR, Div. 4.5, §66264.553	Allows Department of Toxic Substances Control (DTSC) to approve design, operation and closure standards for temporary units used for treatment or storage of wastes generated during remedial actions. DTSC may require alternative standards more protective of human health and the environment.	Relevant & Appropriate	Relevant and appropriate for remedial alternatives that include the use of temporary on-site treatment units.
55	Hazardous Waste Control Act as implemented by Miscellaneous Units	Title 22, CCR, Div. 4.5, §66264.600-§66264.603	Establishes standards for environmental performance, monitoring, inspections and post-closure care for miscellaneous units used in waste treatment, storage, or disposal.	Applicable	Substantive portions will be applicable for remedial alternatives.
56	Water Well Standards	Dept. of Water Resources Bulletin 74-81 and 74-90	Sets requirements for the construction and abandonment of water extraction and injection wells throughout the state.	Applicable	Will apply for any monitoring, injection, or extraction wells constructed or abandoned during remedial actions.
57	Waste Discharge Requirements	Water Code Sec. 13260 et seq. (Porter-Cologne Water Quality Control Act)	Requires filing of a "Report of Waste Discharge" with the RWQCB for any proposed discharges affecting "the waters of the state."	Potentially Applicable	Under CERCLA, on-site actions are exempt from reporting requirements. However, the reporting requirement must be met for any offsite discharges.
58	Policies and Procedures for Investigation and Cleanup and Abatement and Closure	California Water Code 13304 as implemented by State Water Resources Control Board Resolution No. 92-49	Establishes policies and procedures for oversight of investigations, cleanups and abatement activities resulting from discharges which affect or threaten water quality.	Applicable	Applicable for all cleanup and abatement activities which may cause or permit discharges to waters of the state and create or threaten to create a condition of pollution or nuisance in violation of any waste discharge requirement.
59	Hazardous Materials Release Response Plans and Inventory	Health and Safety Code, Div. 20, Chapter 6.95	Establishes requirements for emergency response plans for a release or threatened release of hazardous materials. Reporting requirements are established.	Applicable	Substantiative requirements will be applicable to sites with remedial actions where hazardous materials may be handled.
60	Staff Report of the RWQCB, CVR	"A Compilation of Water Quality Goals"	Provides guidance on selecting numerical values to implement narrative water quality objectives contained in the Basin Plan.	To Be Considered	Performance Standard. To be considered in selecting appropriate numerical values to implement the Basin Plan for setting cleanup levels and discharge limits. The numerical values contained in the staff report may be ARAR's, or Performance Standards, depending on the source of the values.

#	Source	Standard, Requirement, Criterion, Limitation	Description of Standard	ARARs or To Be Considered	Comments
Action-Specific ARARs					
61	Porter-Cologne Water Quality Control Act (California Water Code Sections13000, 13140, 13240, 13260, 13263, 13267, 13300, 13304, 13307)	State Water Resources Control Board Resolution No. 92-49 (As amended April 21, 1994)	Establishes requirements for investigation and cleanup and abatement of discharges. Among other requirements, dischargers must clean up and abate the effects of discharges in a manner that promotes the attainment of either background water quality, or the best water quality that is reasonable if background water quality cannot be restored. Requires the application of Title 23, CCR, Section 2550.4, requirements to cleanups.	Applicable	Applies to groundwater remedial actions.
62	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20090(d), Title 23, CCR. §2511 (d)	Action taken by public agencies to clean up unauthorized releases are exempt from Title 27/ Title 23 accept that wastes removed from immediate place of release and discharged to land must be managed in accordance with classification (Title 27, CCR, Section 20200/ Title 23, CCR, Section 2520) and siting requirements of Title 27 or Title 23 and wastes contained or left in place must comply with Title 27 or Title 23 to the extent feasible.	Applicable	Applies to remediation and monitoring of sites.
63	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20410, Title 23, CCR, §2550.6	Requires monitoring for compliance with remedial action objectives for three years from the date of achieving cleanup standards.	Applicable	Applies to groundwater remedial actions.
64	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20415, Title 23, CCR, §2550.7.	Requires general soil, surface water, and ground water monitoring.	Applicable	Applies to all areas at which waste has been discharged to land.
65	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title, 27, CCR, §20425, Title, 23, CCR, §2550.9.	Requires an assessment of the nature and extent of the release, including a determination of the spatial distribution and concentration of each constituent.	Applicable	Applies to areas at which monitoring results show statistically significant evidence of a release.
66	Porter-Cologne Water Quality Control Act (California Water Code Sections 13140-13147, 13172, 13260, 13263, 13267, 13304).	Title 27, CCR, §20430, Title 23, CCR §2550.10	Requires implementation of corrective action measures that ensure that cleanup levels are achieved throughout the zone affected by the release by removing the waste constituents or treating them in place. Source control may be required. Also requires monitoring to determine the effectiveness of the corrective actions.	Applicable	Applies to groundwater remedial actions.

TO BE CONSIDERED STATE ADVISORIES, GUIDANCE, AND CRITERIA, CAL/EPA, DTSC

i *Institutional Control Protocol at Open Bases*
California Military Environmental Coordination Committee (CMECC)
Site Cleanup Performance Action Team

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From: Springer, David -- Tt, Inc.
Sent: Friday, February 25, 2005 9:27 AM
To: 'Quang Than (qthan@dtsc ca gov)'
Cc: 'Kephart Beatrice (Beatrice.Kephart@vandenberg.af mil)'; 'Gerber Kathleen AFCEE/ICS

(Kathleen Gerber@vandenberg.af.mil)'; 'Atta Amena (Amena.Atta@vandenberg af mil)'; Liu, Sally -- Tt, Inc.;

McNamara, Kevin -- Tt, Inc.; Houlahan, Matt -- Tt, Inc.; 'Bill Meece (RWQCB)'; 'Linda RWQCB Stone

(lstone@waterboards.ca.gov)'; 'Tayseer Mahmoud (tmahmoud@dtsc.ca.gov)'
Subject: Transmittal of Air Force Responses to Supplemental DTSC comments on Draft Site 32C RAW

Importance: High

Hello Quang:

Thank you for your review of the Air Force response to DTSC comment letter. We have reviewed your supplemental concerns provided below and have provided responses in blue-highlighted bold font designed to address each concern. Please review these and let us know whether we have sufficiently addressed your concerns. Following this, please indicate your approval to proceed with issuing the Draft Final document. This e-mail correspondence and the previous regulatory comment/Air Force response to comment letters will be appended to the Draft Final RAW.

Sincerely,

David Springer

-----Original Message-----
From: Quang Than [mailto:QThan@dtsc ca gov]
Sent: Tuesday, February 15, 2005 11:01 AM
To: David.Springer@tetratech.com; Kathleen Gerber@vandenberg.af mil
Cc: Emad Yemut; Quang Than; Tayseer Mahmoud; KEVIN.MCNAMARA@tetratech.com;

Matt.Houlahan@tetratech com; Sally.Liu@tetratech com; Amena.Atta@vandenberg.af mil;

Beatrice.Kephart@vandenberg af mil; Ronald MacLelland@vandenberg af mil; Bmeece@waterboards ca gov;

lstone@waterboards.ca.gov
Subject: Re: Transmittal of Responses to DTSC comments on Draft Site 32C RAW

Hi David,

DTSC has reviewed the subject response to comments, received electronically on 1/26/05, and have the following comments:

1. Response to DTSC Comment 2 b. DTSC finds the response acceptable However, please incorporate the last paragraph on page 5-11 of the Draft Final RI (June 2004) to show that future residents were not evaluated for exposure to chemicals in soil and that the MOA (USAF 1995c) indicates that if future land use changes, the appropriate risk evaluation will be conducted.

Air Force Response:

The last paragraph on page 5-11 of the Draft Final RI will be incorporated into the Executive Summary of the Site 32 Cluster RAW, and at the end of paragraph 1 in Section 4.2.1. The above referenced paragraph is presented below.

Future residents were not evaluated for exposures to COPCs in soil at this site. Sites 32 and 35 are currently, and will continue to be, designated for use as space launch complexes (Vandenberg AFB 2000), making future residential use of Sites 32 and 35 unlikely. As indicated in the MOA among Vandenberg AFB, DTSC, and the RWQCB (U.S. Air Force 1995c), if future land use changes, the appropriate risk evaluation will be conducted

References will be incorporated into Section 10 of the RAW.

2. Response to Comment 3 b i. We defer the evaluation of whether the project violates any water quality standards to the RWQCB.

Air Force Response:

Comment noted Comments and concerns from the RWQCB have been addressed and incorporated into the RAW

3. Response to Comment 3 b iv We defer the evaluation of whether
the emulsified soybean oil injection degrade water quality to the
RWQCB

Air Force Response:

Comment noted Comments and concerns from the RWQCB have been addressed and incorporated into the RAW

4 Response to Comment 8 b. DTSC finds the response acceptable
Please ensure however, that the proposed text for each alternative also
spells out that drinking contaminated ground water will not be allowed

Air Force Response:

Additional text will be included in Sections 5 2.1, 5.2.2, and 5.2 3 stating that "the alternative includes prohibits the ingestion of contaminated groundwater, until final cleanup goals for such use are met."

5 In the ARAR tables, Page 6 lists a "Title 26" at various places.
Please revise them to show "Title 22".

Air Force Response:

For ARAR items 51 through 55, references to "Title 26" will be revised to cite "Title 22", and "Division 22" will be replaced with the correct notation of "Division 4 5" Also, for ARAR item #50, "Title 26" will be changed to the correct notation of "Title 23"

Please provide us with the response to the above comments at your

earliest convenience And contact me if you have any questions

Thanks,

Quang Than

Hazardous Substances Engineer

California EPA/Department of Toxic Substances Control

Site Mitigation Branch/Office of Military Facilities

5796 Corporate Avenue, Cypress, CA 90630

714 484 5352 714 484 5437 (fax)

>>> "Springer, David -- Tt, Inc " <David.Springer@tetratech com>

1/26/2005 5:03:57 PM >>>

Good afternoon: Please find attached the Air Force response to RWQCB

comments on the above referenced document Following your review of

the

attached, please contact us with any remaining questions, if necessary,

or

indicate your concurrence in a return e-mail.

Sincerely,

David S. Springer, R.G

Principal Hydrogeologist

Tetra Tech, Inc

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